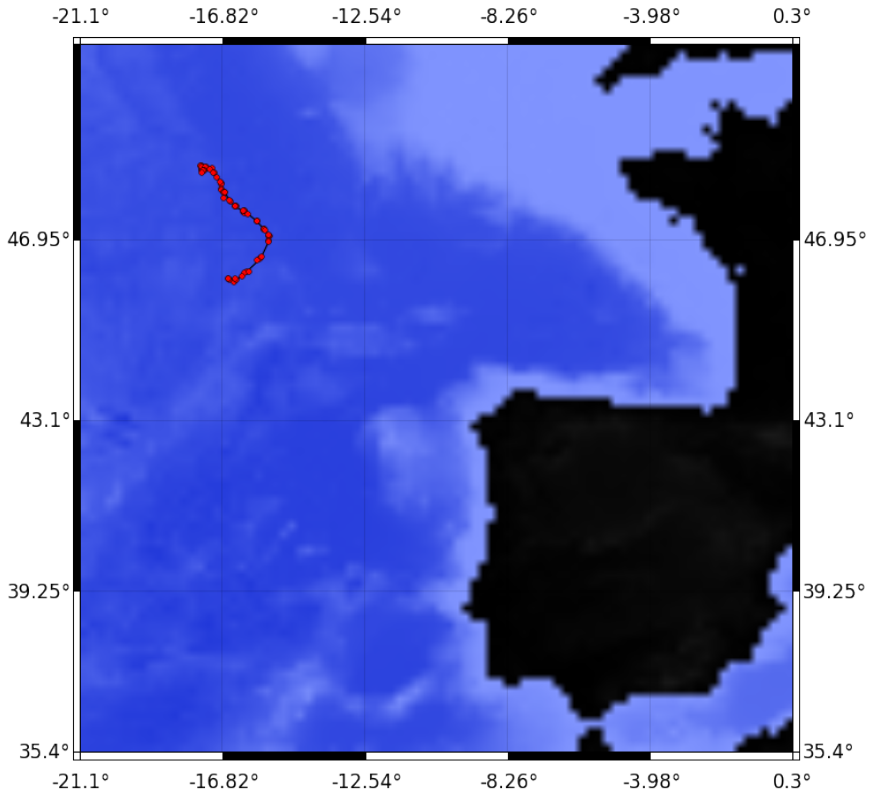
CRUISE REPORT: 74AB19900525

(Updated JAN 2014)



Highlights

Cruise Summary Information

WOCE Section Designation	**74AB19900525**
Expedition designation (ExpoCodes)	**74AB19900525 (**74AB047, 74AB19900528)
Chief Scientists	**Dr. Peter H. Burkill/PML**
Dates	1990-MAY-25 - 1990-JUN-18
Ship	*RRS Charles Darwin*
Ports of call	Barry, UK
Geographic Boundaries	48° 26' N 17° 28' W 15° 24' W 46° 3' N
Stations	71
Floats and drifters deployed	0
Moorings deployed or recovered	0

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Links To Select Topics

Shaded sections are not relevant to this cruise or were not available when this report was compiled.

Cruise Summary Information	Hydrographic Measurements
Description of Scientific Program	**CTD Data:**
Geographic Boundaries	Acquisition
Cruise Track (Figure): PI CCHDO	Processing
Description of Stations	Calibration
Description of Parameters Sampled	Temperature Pressure
Bottle Depth Distributions (Figure)	Salinities Oxygens
Floats and Drifters Deployed	**Bottle Data**
Moorings Deployed or Recovered	Salinity
	Oxygen
Principal Investigators	Nutrients
Cruise Participants	Carbon System Parameters
	CFCs
Problems and Goals Not Achieved	Helium / Tritium
Other Incidents of Note	Radiocarbon
Underway Data Information	**References**
Navigation Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	
Thermosalinograph	
XBT and/or XCTD	
Meteorological Observations	**Acknowledgments**
Atmospheric Chemistry Data	
Data Processing Notes	

Plymouth Marine Laboratory
Cruise Report

RRS CHARLES DARWIN
Cruise 47/90
25 May - l8 June 1990

Principal Scientist
Dr P H Burkill

BIOGEOCHEMICAL OCEAN FLUX STUDY
BOFS Leg B2

A Lagrangian study of biogeochenilcal processes in the surface mixed layer centred at 48°N 17°W in the northeast Atlantic Ocean

A component of the Joint Global Ocean Flux Study

March 1991

CONTENTS

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Helen Chadd	PML & University of Warwick[1, 5]
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1.2 Ship's staff

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Rob Atkinson	3rd Officer	Simon Dean	3rd Engineer
Jeff Baker	Radio Officer	Phil Parker	Elect'l Engineer
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Gary Crabb	Seaman	Phil Dean	Seaman
Andy Scriven	Seaman	Dave Buffery	Seaman
Cohn Hubbard	CPO(C)	Pete Bishop	Cook
Jeff Orsborn	2nd Steward	Dave Jenkins	Steward
Pete Duhameau	Steward	Dave Hanlon	Motorman

2. SUMMARY: OBJECTIVES & ACHIEVEMENTS

The Lagrangian Experiment, the main BOFS 1990 field programme, comprised five cruise legs of which DARWIN 47/90 was the fourth. The Langrangian Experiment was designed to follow the temporal and spatial variability in fluxes of carbon and other biogenic elements associated with the phytoplankton spring b100m in the mid-latitude north-east Atlantic Ocean. The Experiment involved two ships, DISCOVERY and DARWIN, in simultaneous studies of spatial variability and mid-water studies (DISCOVERY 190, 191 & 192/90, April 14 to June 27) and surface mixed layer process studies (DARWIN 46 & 47/90, April 28 to June 18) centred on a common drift station. As a Lagrangian base for the drift station, a Metocean-Argos buoy (#3917) drogued at 20-metres depth, was used. Buoy 3917 was deployed on 26 April within a meso-scale eddy at 49° 05'N, 19° 15'W by DISCOVERY 190.

The aim of DARWIN 47/90 was to study the time-varying fluxes of carbon mediated by natural communities of the surface mixed layer associated with the drift station. The cruise aim was divided into a series of objectives which addressed:

i) the *in-situ* production and utilisation of CO_2, O_2 and nutrients;

ii) the assimilation rates of inorganic carbon and nitrogen by different size fractions of phytopiankton as controlled by light, nutrients and trace metals;

iii) primary production and community respiration by high precision O_2 measurements;

iv) cyanobacteria and their expression of gene activity;

v) bacterial biomass and productivity and its relationship to primary production;

vi) phytopiankton biomass and taxonomic composition by microscopy, high performance liquid chromatography (HPLC) and analytical flow cytometry (AFC);

vii) micro- and meso-zooplankton biomass and their herbivorous impact on phytopiankton;

viii) the vertical distribution of inorganic and organic 'biomarkers' including ^{15}N isotope, ^{210}Po, ^{210}Pb and ^{234}Th radionuclides, pigments, lignins, POC & PON using Stand-Alone Pumps (SAPS);

ix) "Level 1" core parameters as part of the JGOFS/BOFS Atlantic programme.

All objectives were successfully met on DARWIN 47/90 using repetitive sampling of the water mass in the vicinity of buoy 3917 by CTD with Niskin bottles, GoFlo bottles, plankton nets and Stand-Alone Pumps (SAPS), in conjunction with appropriate experiments.

Primary production rates were experimentally determined using *in-situ* incubations with uptake of ^{14}C and ^{15}N isotopes coupled with O_2 production and CO_2 incorporation (see Sections 5.1, 5.2, 5.3, 5.4). *In-situ* incubations of 24h duration were carried out using free floating rigs tethered to the ship. A total of 13 *in-situ* incubations were achieved.

Phytoplankton concentrations were determined onboard ship from chloropigment concentrations obtained on vertical profiles. Chlorophylls and carotenoids in phytoplankton were measured by fluorometry and by HPLC analysis of samples obtained from water bottles and from SAPS (Section 5.8). A total of 35 pigment profiles and 28 SAPS casts were carried out.

Cyanobacteria, a potentially important component of the phytoplankton, were studied using molecular genetic and other physiological approaches (Section 5.5). Nine profiles of cyanobacteria and around 50 samples for molecular anayses were obtained. Thirteen profiles for the characterisation of phytoplankton and other particles by AFC on the basis of light scatter and autofluorescence of individual particles (Section 5.9) were carried out. Twelve profiles of phytoplankton samples were also taken for microscopic analysis in the laboratory (Sections 5.3 & 5.11).

Bacterial production was determined experimentally twelve times using the incorporation of ^{3}H-thymidine into bacterial nucleic acid, while samples were collected for subsequent determination of bacterial numbers and biomass in the laboratory (Section 5.3).

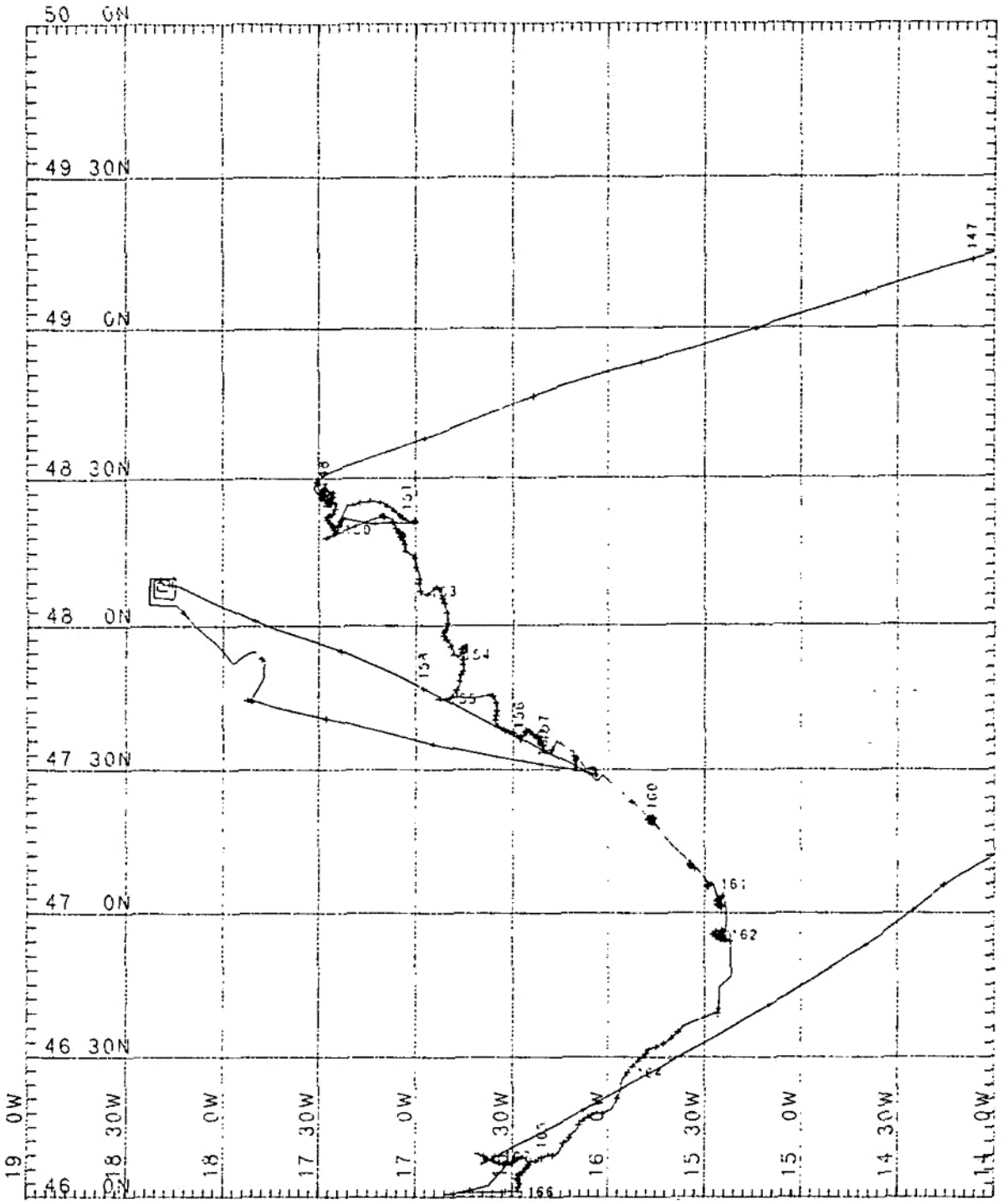
Micro- and meso-zooplankton populations were sampled repetitively using water bottles and nets for later analysis in the laboratory while their herbivorous activity was determined experimentally on board ten times using dilution and Chadd fluorescence techniques (Sections 5.10 & 5.11). Six of the latter were achieved within the 3-day cycle of mesozooplankton sampling and experimentation.

Nine profiles for the analysis of stable isotopes, 16 for radionuclides and 24 for POC and PON were obtained using water bottles and SAPS (Section 5.6). Forty-two profiles of inorganic nutrient concentrations were measured using auto-analysis (Section 5.7).

At the end of occupancy of the drift station, buoy 3917 was lifted. The drogue was found to be missing. At the moment it is not known when the drogue became detached from the buoy and how this influences interpretation of the Lagrangian time series. Clearly, answering this is critical to setting the very successful science carried out on this cruise within a suitable framework.

Table 2.1: Utilisation of Shiptime.

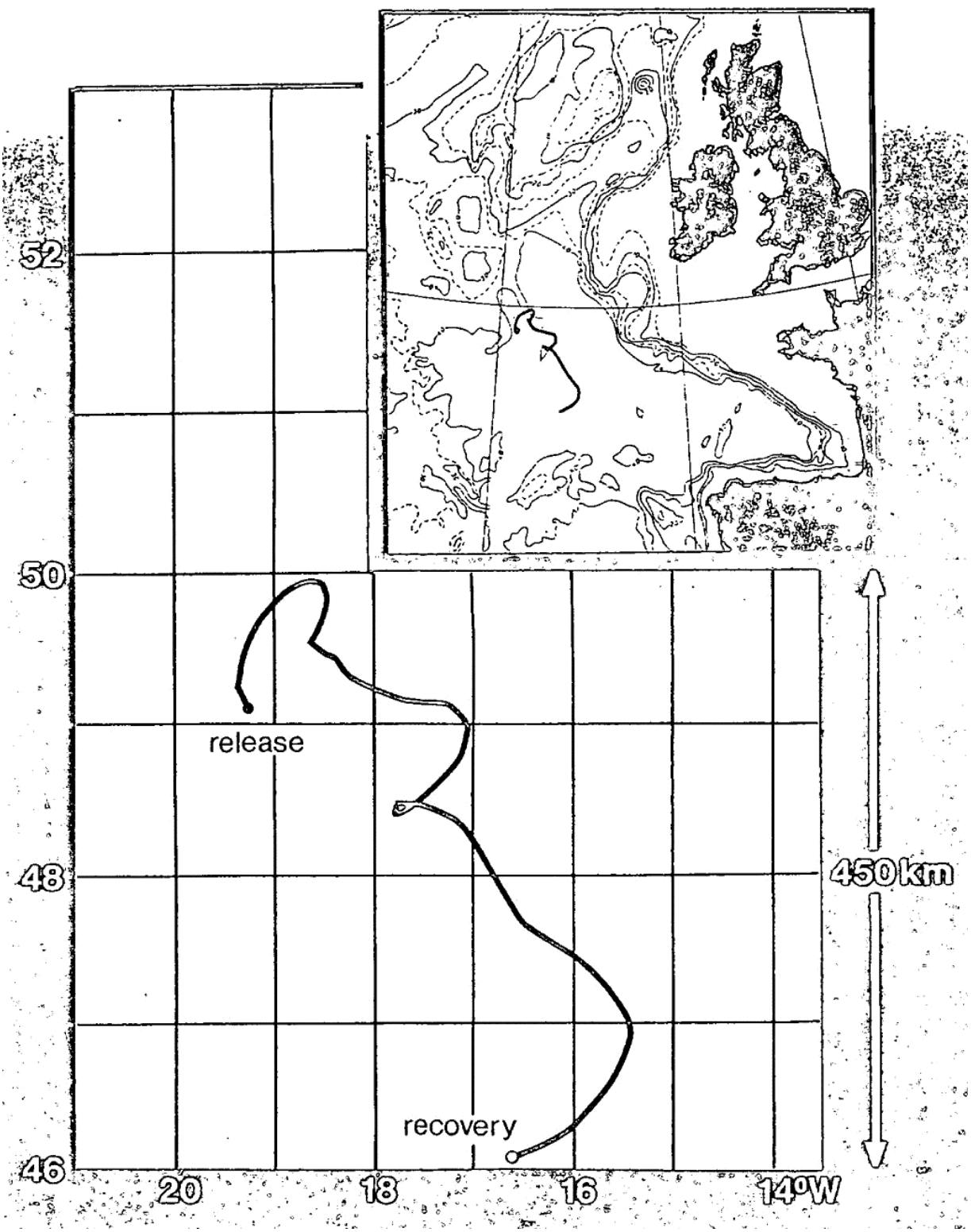
Sailed from Barry			1014A	25/05/90
Arrived Station (48° 29.0'N 17° 30.6'W)			l300A	27/05/90
Departed Station (46° 06.9'N 16° 39.7'W)			0030A	16/06/90
Arrived Barry			1316A	18/06/90
Cruise time		24 days 3 hours		579 hours
Steaming time	outward	2 days 4 hours		52 hours
	inward	2 days 13 hours		61 hours
	Total	4 days 17 hours		113 hours
Scientific time	on station			436 hours
	recovery of sediment trap			31 hours
	Total	19 days 11 hours		467 hours
Down time	Whole ship			nil
	Part ship			17.5 hours
		29 May: deep ctd		4 hours
		30 May: rig		2 hours
		2 June: deep ctd		1.5 hours
		12 June: winch creep		2 hours
		15 June: heavy weather damage		2 hours
		15 June: damage to CTD frame		6 hours



MERCATOR PROJECTION GRID NO. 1
SCALE 1 TO 2750000 (NATURAL SCALE AT LAT. 0)
INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

RRS Charles Darwin 47 (B2) Cruise Track

Track of central buoy, 26 April -15 June



3. NARRATIVE

We sailed from Barry at l0l4A on **25 May**, in fair weather and with a gentle swell, passed south of Lundy and headed west-sou-west to the Atlantic. Onboard all hands prepared their equipment for the forthcoming 24 days at sea. After lunch, all scientists assembled in the main lab at the request of the Master for a briefing on emergency procedures and fire-fighting aboard the ship.

By **26 May**, the sea had changed colour from the turbid brown waters of the Bristol Channel to blue waters of the Continental Shelf. On nearing the Shelf Break, numerous milky white patches of coccolithophore b100ms were seen. The ship hove-to at 1100 to carry out a shake-down station at 49° 44.4'N 10° 25.5'W. The CTD drop had to be aborted due to 'Level A' interface problems which were to remain with us for some time. A plankton hand-net tow for appendicularians produced Fritillaria rather than the desired Oikopleura. We resumed passage with sundry birds (kestrel, sandmartin, pigeon) hitching a mistaken ride further away from land. At 2100, the bridge reported a 'Port–Hand' navigation buoy ahead- leaving those in the lab wondering which port we were approaching! This not insignificant object with a sonerous bell was reported to Trinity House as a navigation hazard, and we continued on our journey. That evening we encountered the long, low swell typical of the open ocean.

We reached the BOFFING ground (48° 29.0'N 17° 30.6'W) at 1315 on 27 May, joining DISCOVERY who had been working the station alone since DARWIN left on 20 May. Earlier VHF communications between the two ships had arranged transfer of supplies from Barry. Plans were also made for an intercalibartion exercise for 29 May. Doriel Jones transferred to DISCOVERY taking the sick Level-A interface to be inspected by the RVS computer hardware specialist on board. Later in the day, the salinity channel on the thermosalinograph was noticed to be malfunctioning. On stripping down, the salinity sensor head was diagnosed as suffering from corrosion and required replacement. The nearest spares were eventually traced to the instrument manufacturer in the USA as, apparently, these units never go wrong!! We were therefore without continuous salinity measurements. The resulting feeling of frustration at major equipment malfunctionwas tempered by an eagerness of the scientists to initiate their sampling and experimentation on station.

Station work began at 1619 with a successful SAPS deployment, followed by nettings for zooplankton at 1930 and 2335. This latter activity initiated the 3-day cycle of sampling that the mesozooplanktologists maintained throughout the period that DARWIN was on station. Fog descended that evening and remained until the next day.

On **28 May**, the first full day on station began at 0410 with water collection by GoFlo for CO_2, O_2, ^{14}C and ^{15}N primary production incubations. Experimental bottles with appropriate additions of isotopes were incubated *in-situ* using free-floating 'production rigs' deployed just prior to dawn. The production rigs were coupled together and the joint rigs assembly tethered to the ship's stern with 70 metres of line. Water was collected at 0545 for a microzooplankton grazing experiment. CTD water sampling (minus Level 'A' logging) began with three morning casts for phytoplankton, microzooplankton, pigments, POC/N and other particulate components in the surface mixed layer.

Doriel Jones returned from DISCOVERY at 1045 with the Level A interface-board. This could not be fully tested before evening because a bad connection was identified in the interface. The CTD, deployed at 1800, was found to be passing data intermittently. The CTD problems were now shifted to the deck unit. Meanwhile netting, SAPS and GoFlo casts continued. The SAPS record (100% intact filters recovery from 2 deployments) was particulary gratifying.

The first day on station showed that the salinity and temperature of the surface waters were 35.6‰ and 14.6°C with a thermal gradient of 2.9°C over the top 60M. The chlorophyll maximum of 1.5 µg litre^{-1} was situated at 10 metres.

By midnight, DARWIN had drifted with the *in-situ* rigs tethered to the ship, 3 nautical miles away from buoy 3917. After rig recovery at 0300, the ship steamed back to buoy 3917 and sampling work for the next day started again.

The sampling and experimentation described for the first full day on station established the scientific pattern for much of the next 20 days. In the remainder of the narrative, only departure from this and other points of interest are outlined. The detailed daily pattern of scientific activity is given in Sections 5 and 7.2.

The 0600 CTD drop on **29 May** proceded without mainframe logging because of the spurious data derived through all channels of the deck unit. The 1150 deck-unit was swapped for the spare 1401 unit which although it ran, required a different HEX file which was unavailable. The HEX file had to be written and transmitted from Barry; this was finally received on 5 June!

Sampling for JGOFS/BOFS "Level 1" parameters took place every Tuesday and Saturday during the cruise. "Level 1" activities involved 2 casts (CTD-300M & CTD-4000M) which were carried out during the morning and afternoon. The first "Level 1" day was used to intercalibrate nutrients, pigments and bacteria with DISCOVERY. The results are reported in Section 5. Standard operational procedures for "Level 1" sampling adopted on BOFS 1989 cruises were followed, samples for gas analysis (CO_2 and O_2) were drawn directly from the water bottles. The remaining water from each bottle was decanted seperately into carboys for other biological and chemical determinations (a full list is provided in Section 7.4). Recovery of the first deep "Level 1", deployed at 1505, was considerably delayed because of spooling problems on the winch. At 2000M on the uphaul, the cable was found to be out of alignment with the spooler. The CTD was payed out to 4000M and rewound slowly. This took 2 RVS staff to Chadd the wire on to the drum while another technician drove the winch. As a result, the cast took 7.5 hours instead of the 3.5 hours allocated. A message was sent to Barry about this because although the ship's personnel knew this was a regular feature of the winch, neither RVS technicians nor the scientists had been informed.

In the early morning of **30 May**, a storm developed which caused the *in-situ* rig to part from the ship. Fortunately, the departing rig was spotted in time to be grappled successfully; however, this delayed the schedule by 2 hours. Inspite of heavy swell, the weather was favourable and the rig was deployed again. Our sampling and experiments proceded according to plan until haevy weather returned that evening. On **31 May**, all ^{14}C samples from the rig were lost due to another storm and the toroid from the rig was badly buckled. A decision was made to delay further rig deployment until the weather abated.

Inspite of the storms, the sea surface temperature had warmed by 0.3°C over the previous 3 days while the surface fluorescence had dropped by 15%. The chlorophyll maximum had now sunk to 30 metres from the sub-surface.

By **1 June** the sea swell had moderated to 5 metres and the sun shone. A notable find that day was the presence of a colonial cyanobacterium, *Trichodesmium,* in the water. This provided excellent scope for many onboard to investigate, on a science-of-opportunity basis, the physiological activity and genetic expression of this alga which is capable of fixing N_2 (further details in Section 5.5).

On **2 June** the swell had subsided further to 6-8 feet and the weather remained bright but overcast. "Level 1" casts were completed, although the deep cast to 4900M took 5 hours and required 3 RVS personnel to Chadd and drive the winch on the uphaul. The following day (**3 June**) was sunny and the sea surface temperature had warmed significantly (now 15.2°C) since arrival on station. Thermal gradient had increased to 3.2°C over the top 60M. Chlorophyll levels had reduced little, if at all, while the nitrate concentation remained low (0.2 to 0.6 μmol litre^{-1}) but measurable by autoanalysis. CTD operations were hampered by shorting of Marsh & Marine plugs which were replaced three times and the cable cropped before, on **5 June** the shorting problem was fully rectified.

A storm force 7/8 blew up on the night of 5/6 June and blew hard for most of **6 June**. The production rig lost 2 floats in the storm and at one point was almost totally submerged. Careful handling ensured that no bottles were lost in the recovery of the rig. When the Dhan buoy was recovered water poured from it. Was it punctured while pulled underwater or did it implode under pressure? Either way, the production experiment had to be written off.

The storm provided a Chadd opportunity that evening to reassess our science and a lively discussion was ensuing when a R/T call from PML asked whether we could attempt recovery of the one remaining BOFS drifting sediment trap involved in the Lagrangian Experiment. Argos transmissions from the trap array had suddenly grown weak and it was clear that the Lagrangian Experiment could be without any sedimentation data. DARWIN left station at 2040 and made for the last Argos fix position - 100 nautical miles to the NW. We arrived at this location (48°08.5'N 18°18.4'W) at 0720 on **7 June** and commenced a box search with scientists manning the RDF which was tuned to the Novalech transitter frequency of 160.785 MHz. By lunchtime nothing had been found. Robin Pingree (PML) suggested that the last Argos fix was almost certainly wrong. We moved the search to a new location based upon the previous course of the trap. A R/T signal was picked up by Tim Fileman at 1530 and confirmation that we had found buoy 3911 occurred when it was sighted by Helen Chadd. Inspite of heavy seas, little information about the rig design and lack of suitable lifting gear, recovery was 100% successful with 4 traps and an Anderaa current meter lifted on board by 1921. Suitable messages were sent to PML and Richard Lampitt (IOSDL) reporting that his traps had been recovered intact from 47°43.9'N 17°5l.3'W.

Darwin returned to buoy 3917 overnight, reaching station (47°19.7'N 15°47.7'W) on **8 June**. Station work proceded with GoFlo casts for *in-situ* production incubations at 0405. The wind had abated to force 5 and dropped further later.

By **9 June** we had settled back into our earlier scientific routine again with productivity rigs, CTD and bottle sampling, netting and SAPing in the calm (force 3) weather. A short diversion was provided in the evening to celebrate the Queen's birthday - an excellent barbeque prepared by the galley staff on the stern deck. It was a pleasant break from the normal culinary routine!

On **10 June** the weather had increased to force 5 and had turned overcast. A SAPS time series of 36-h duration with sampling every 6-h started at 0710. By late afternoon the wind had dropped to 10 knots and the sun shone. The increase in morale was further hightened when a pair of Fin whales were sighted close by the ship. These marvellous creatures often ventured to 25 metres from the ship and remained in the vicinity throughout **11 June**. Later on this day, the mainframe computer crashed and Doriel Jones had difficulties keeping it running. The problem was hardware related and need specialist help.

We welcomed DISCOVERY 192 on station at 1010 on **12 June**. Plans for an intercalibration between the two ships had previously been agreed. Before this proceded, Andrew Cormack (RVS) transferred from DISCOVERY and successfully resolved our hardware problem. Intercalibrations focussed on nutrients and oxygen which were considered important since the previous intercalibration with DISCOVERY 191 had shown discrepancies in these two variables. "Level-l" CTD-300 and CTD-2000 were carried out

simultaneously by both ships with water being swapped and analysed on both DARWIN and DISCOVERY. DISCOVERY also kindly provided various scientific supplies urgently requested from PML and Barry. The Fin whales, now with two ships in close proximity, oscillated between the two vessels before departing in the afternoon.

The TSG problem identified on 27 May was rectified on 12 June when Andy Jones inadvertently discovered that a switch on the interface was set to the wrong position. Salinity readings from the non-toxic supply were properly logged after this. Before the 1800 CTD-300 deployment, the CTD winch was found to have crept forward disgorging about 30 metres of cable onto the deck. Some of this had jammed in the winch gearing causing damage to the cable. The cable had to be terminated and rejoined, causing delay to the programme. The evening cast had to be made with GoFlo bottles.

At various times on **13 & 14 June** intercalibration results were discussed between DISCOVERY and DARWIN. Preliminary analysis of O_2 and nutrient results were very encouraging and are reported further in Sections 5.1 & 5.7. A storm blew up on the night of **14/15 June** causing contact with buoy 3917 to be lost in the heavy seas. It took 2 hours to locate the buoy using radar and RDF. The delay to the programme was added to when the CTD frame crashed sideways onto the deck as a result of wire creep. On this occassion the wire had looped around stag-horns situted on the bulk-head and resulted in considerable structural damage to the CTD frame. The bent components had to be replaced and the frame tested before deployment.

An end to our station work was insight when buoy 3917 was lifted at 1335 on **15 June**. On lifting the drogue however, no drogue was attached. The question in everyone's mind was - when did the drogue come off? Answering this is clearly important as it provides a frame work for all our scientific endeavours. Following recovery of the buoy, GoFlo casts, the final "Level 1" CTD and zooplankton netting continued until we left station (46°07.4'N 16°38.4'W) at 0030 on **16 June.** A course of 058°T was set and DARWIN steamed for Barry.

The fine sunny weather added to the high spirits that prevailed and an excellent traditional end-of-cruise RPC was held which lasted well into the morning.

Activity on **17 June** started late. Scientists packed while the RVS technicians streamed the CTD cable astern to tension it on the winch drum. This operation began at 1015, was completed by 1310 allowing DARWIN to make full speed. The next day (**18 June** produced a wet welcome home with squally showers blowing DARWIN up the Bristol Channel. We were pleased to arrive in port at 1317A after a successful and happy cruise.

During the 19 day occupancy of the Lagrangian drift station, buoy 3917 moved a distance of ca 220 nautical miles, as is shown in Figure 1. Between 27 May and 11 June, the buoy moved in a south easterly direction at an average rate of 10 tim per day; after 11 June, its course veered round to the south west and speed increased to ca 20 tim per day. The region covered during the latter part of the buoy's movement was surveyed by DISCOVERY 192 and the oceanographic data from this cruise will be available for interpretation of the Lagrangian drift station work performed on DARWIN 47/90.

4. ACKNOWLEDGEMENTS

Oceanographic research ultimately distills down to teamwork. The DARWIN 47/90 team included not just personnel aboard the ship but also others who supported the cruise from elsewhere. It is therefore particularly pertinent, and a great pleasure, to gratefully acknowledge the support and help of:

Captain Keith Avery, his fellow officers and crew whose tireless professionalism ensured not only that the ship operated smoothly, but that we also enjoyed the cruise too;

Doriel Jones, Mike Davies, Chris Rymer and Andy Jones of RVS who provided excellent support of our science inspite of the many gremlins which surfaced on the cruise;

Ian Innes whose calm approach to our requirements for logistic support from RVS Barry was an example to us all;

Phil Williamson, who as BOFS Project Manager, ably and cheerfully coordinated the planning and execution of the Lagrangian Experiemnt;

Robin Pingree and Bob Barrett of PML and Steve Groom of NCS, Plymouth Polytechnic for providing daily updates from Plymouth of Argos buoy positions and other BOFS matters relevant to the Lagrangian Experiemnt;,

Dave Joyce and Cordon Siley of PML who assisted us in shifting 6 tonnes of scientific equipment to Barry and back, and ensuring it was safely anchored before we sailed;

Graham Savidge (QUB), Martin Angel (IOSDL), David Turner & Andy Watson (PML), who as Principal Scientists of the other 1990 BOFS summer cruises, provided excellent collaboration and ensured the success of the complex Lagrangian Experiment we had collectively undertaken.

5. SCIENTIFIC ACTIVITIES

5.1 Primary Production Respiration and O_2 Measurements

(Duncan Purdie)

The aim of the research was to determine daily values of gross and net primary production and community respiration rates through the euphotic layer in the vicinity of a drogued buoy which had previously been released in the region of 20°W 47°N . *In-situ* rates of oxygen flux were determined in glass bottles incubated at up to 5 depths within the euphotic zone. Both light and dark bottles (4 reps per depth) were suspended on a line from a surface buoy tethered to a Dhan buoy which was attached to the ship. Primary production measurements were made at the same time using a precise TCO_2 method (E. Wood) and the 11/4 technique (A. Pomroy).Oxygen was measured using an automated precise Winkler titration procedure. Water samples were collected between 4.00 and 5.00am using Co-Plo bottles from initially depths of 2m, 10m, 20m, 35m and 75m. Later experiments were conducted using water collected from 2m, 10m, 15m, 25m, and 35m. A list of dates and depths sampled is presented below. The incubation rig was usually deployed by 6.00am and recovered by 2.30am the following morning. One evening deployment was conducted on 9 June to determine if rates of production were influenced by the migrating zooplankton populations which also appeared to be influencing the replication of incubated samples. One experiment was conducted to determine if prefiltration through a 200 µ mesh improved the replication errors by removing larger zooplankton.

Rates of gross production in surface waters generally compared favourably with both TCO_2 rates and ^{14}C uptake rates. Acceptable (provisional) Photosynthetic Quotients between the two gas flux methods were obtained (aprox 1.2 to 1.5). Initial rates were of the order of 10 µmolO_2/kg per day at 2m decreasing to less than 1 µmolO_2/kg per day at 75m (28, 29 May). Rates of gross production at 2m then decresed over the following 10 days to a value of circa 5 pmol/kg per day and were no longer measurable below 25m by the 14 June. Net Production was generally only positive at 2m on all dates and respiration rates were similar in the surface 15 m then decreased with depth.

Four experiments were conducted using an on-deck incubator with 6 screened natural light levels. A water sample taken from within the surface chlorophyll layer was incubated on each occassion for circa 12 hours and TCO_2 and ^{14}C measurements also made. The production rates compared well at most light levels and this data will be modelled to determine water column production.

***Table 5.1**: Depths at which in-situ experiments were conducted.*

Date	Depths (m)					
28.5	2	10	20	35	75	
29.5	2	10	20	35	75	
30.5	2	10	20	35		
31.5						
1.6	2	10	20	35	75	
2.6	2	10	20	35	75	
3.6	2	10	20	35		
4.6						
5.6	2	10		25	35	
6.6	2	10	15	25	35	(Abandoned)
7.6						
8.6	2	10	15	25	35	
9.6	2	10	15	25	35	(evening deployment)
10.6						
11.6	2	10	15	25	35	
12.6	2	10	15	25		
13.6	2	10				
14.6	2	10				
15.6	2	10	15	25	35	

Level 1 dissolved oxygen measurements were made on all shallow casts to 300m and deep casts to 4000m and later 2000m. Samples were collected on the following dates: 29 May, 2, 5, 9, 12 and 16 June. An intercomparison of deep water oxygen concentrations was undertaken on 9 June with P.J. Le B. Williams on the R.R.S. Discovery. Generally all values compared well (see Table 5.1.2)

***Table 5.1.2:** Results of oxygen level 1 intercomparison with P.J. Le B. Williams on DISCOVERY 192, 12 June 1990*

Depth (m)	Oxygen conc. µmol/kg ±S.D.				Diff.
	Discovery		Darwin		
400	251.74	0.25	251.91	0.04	+0.17
500	251.33	0.12	250.88	0.23	+0.45
600	246.02	0.50	246.99	0.49	+0.97
700	242.50	0.10	245.67	0.20	+3.17
800	209.76	0.18	209.14	0.37	-0.62
1000	196.16	0.07	197.16	0.07	+1.00
1200	219.13	0.04	218.77	0.03	-0.36
1500	249.28	0.12	248.16	0.17	-1.12
2000	266.86	0.16	257.82	0.52	-9.04

A pulsed oxygen electrode system was used to measure dissolved oxygen in the non toxic subsurface intake however due to an electronic malfunction the controller was not operating between the 1 June and 12 June. The surface oxygen concentration did show a diurnal variation during the later few days of the cruise. The CTD oxygen electrode will be fully calibrated from both discrete oxygen measurments and

from the surface pulsed oxygen electrode data at a later stage, however a provisional plot of electrode data suggested the CTD sensor was responding well.

A 'remarkable data set' was obtained on this cruise which was due to a number of factors. Few equipment problems were experienced and the oxygen analyser generally produced very reproducable data. The friendly atmosphere and helpful nature of all the ships crew and officers is acknowledged. I thank all my scientific colleagues and the RVS staff for making this a very enjoyable cruise and particularily thank Emily Wood for her willing help in setting up the productivity rigs and for being such great company through out the cruise. Finally my thanks to Peter Burkill, the PSO, for taking on the task and organising the cruise logistics and the work program so efficiently.

5.2 Primary productivity (TCO_2, ^{15}N)

(Emily Wood)

Cruise objectives I intended to continue measurements of primary productivity in the same manner as those taken on the previous cruise to obtain as consistent a data set as possible. I wanted to obtain as many productivity measurements as possible using the coulometric method for the analysis of total inorganic carbon, which could be directly related to the oxygen data obtained by Duncan Purdie and the ^{14}C data obtained by Alan Pomeroy. I also intended to take simultaneous measurements of new production using $^{15}NO_3$ and $^{15}NH4$ uptake experiments. I intended to fulfill the Level 1 protocol for TCO_2 by sampling every shallow level I cast and a deep profile at the beginning and the end of the cruise.

Method Primary productivity measurements were taken by collecting water at 04:00hrs and incubating *in-situ* for 24hrs in the "chicken cages". TCO_2 was sampled directly after O_2 from the same GoFlo. On depths where TCO_2 was sampled ^{15}N samples were taken from a seperate GoFlo, otherwise they were taken after O_2 and ^{14}C. TCO_2 measurements of Gross production, Net production and community respiration were made using light/dark bottle incubations and analysed as directly as possible. Due to the length of analysis time some of the samples have still to be analysed. ^{15}N samples were filtered directly and frozen to be analysed back at PML. The filtate was size fractionated to greater and less than 5pm fractions.

A comparison of *in-situ* and in-vitro measurements was made using the deck incubators from Southampton University, 3 production versus irradiarice measurements were made for 12 hrs at 6 light levels.

Samples taken a total of 14 productivity experiments were taken, 12 of which were dawn to dawn incubations, 1 was a dusk to dusk incubation and one was abandoned due to adverse weather. A final incubation would have taken place had we not failed to find the marker buoy to which we returned every morning to sample at.

3 P/I experiments were run on deck for 12 hrs.

The level 1 requirements were met to the extent necessary.

***Table 5.2.1**: Experiments carried out.*

Date	Depth sampled ^{15}N	Depth sampled TCO_2	Comments
28/5	2, 10, 20, 35, 75	2, 10, 20	*in-situ* dawn/dawn
		2	*in-vitro* dawn/dusk
29/5	2, 10, 20, 35, 75	2	*in-situ* dawn/dawn
30/5	2, 10, 20, 35	2	*in-situ* dawn/dawn
01/6	2, 10, 20, 35, 75	2, 10, 20	*in-situ* dawn/dawn
02/6	2, 10, 20, 35, 75	2	*in-situ* dawn/dawn
		2	*in-vitro* dawn/dusk
03/6	2, 10, 20, 35	2	*in-situ* dawn/dawn
03/6	2, 10, 25, 35	2	*in-situ* dawn/dawn
06/6	2, 10, 15, 25, 35	2, 10	aborted due to weather
08/6	2, 10, 15, 25, 35	2, 10, 15	*in-situ* dawn/dawn
09/6	2, 10, 15, 25, 35	2	*in-situ* dusk/dusk
11/6	2, 10, 15, 25, 35	2, 10, 15	*in-situ* dawn/dawn
12/6	2, 10, 15, 25	2	*in-situ* dawn/dawn
14/6	2, 10	2, 10, 15	*in-situ* dawn/dawn
15,6	2, 10, 15, 25, 35	2	*in-situ* dawn/dawn
P/I experiments: 06/6 11/6, 15/6			
Level 1			
29/5	TCO_2	all depths shallow	295/c06
	TCO_2	all depths deep	295/c10
03/6	TCO_2	all depths shallow	026/c08
05/6	TCO_2	all depths shallow	056/c09
09/6	TCO_2	all depths shallow	096/c07
12/6	TCO_2	all depths shallow	126/c08

Results

The coulometer behaved very well apart from one day which was lost due to a valve failure. I have been able to analyse most of the TCO_2 samples at sea and the remaining samples will be analysed on returning to Plymouth. The ^{15}N samples will be analysed as soon as possible at PML. We have not had time to take a close look at our data but provisionally the TCO_2 data seems to be in Chadd agreement with the O_2 data. RQ values obtained are all sensible (1-2). RQ values seem too high but need to be looked at in more detail. I await ^{14}C data to see how the TCO_2 has compared with that. Very briefly, I have seen a continual decrease in productivity from the last cruise (provisional data will be presented in Duncan Purdie's report for the O_2 analysis - Section 5.1).

I am very pleased with the amount of experiments we have been able to run. Our results have been exceptionally rewarding to me in that it seems that some of the problems encountered using TCO_2 as a method of measureing productivity have been overcome and the precision has improved considerably.

I would like to thank Duncan Purdie for helping to make this "unique"data set possible and for being such a pleasure to work with(?). Of course many thanks to the crew who struggled with my cages every

morning in not always the most agreeable conditions, thanks to every one I have worked and played with and finally thankyou to Peter Burkill for making it all happen!

5.3 Primary (^{14}C) & Bacterial Productivity

(Alan Pomroy)

In-situ primary production

a. Level one determinations of the rate of uptake of ^{14}C-CO_3 were successfully completed at the following depths on 12 occasions; 2, 5, 10, 15, 20, 25, 30, 35 and 40 metres. Triplicate samples and a dark control were incubated at each depth for 24 hours from dawn to dawn before filtration. All samples were size-fractionated into >5µm, <5 - >lµm and <1µm - >0.2µm fractions. In addition deployments on the 30th May and the 6th June were unsuccessful due to damage to the *in-situ* rigs as a result of adverse weather.

b. An intercalibration with the Discovery was carried out on 29th May using an on-deck, simulated *in-situ* incubator representing depths of 2, 5, 10, 15, 25 and 35 metres.

c. On deck incubations comparing rates of uptake of with those of oxygen production and carbon dioxide consumption were carried out at 6 light levels on the 11th and 15th June.

Bacterial production

a. Level one determinations of bacterial uptake of tritiated thymidine were completed on 12 occasions at the following depths; 2, 5, 10, 15, 20, 25, 30, 35, 40 and 75 metres. 4 replicate samples and a control were incubated from each depth at *in-situ* temperatures.

b. On the ist June a sample from the non-toxic supply was incubated in the on deck, simulated *in-situ* system at light levels representing 2, 5, 10, 15, 25 and 35 metres to determine if the rate of bacterial production was directly related to the production of DOC by phytoplankton at different light intensities.

c. On the 2-3rd June rates of thymidine uptake were determined at 4 hour intervals for 24 hours, using water from 10 metres to establish if bacterial production showed a diel cycle.

Bacterial numbers

Samples preserved with 2% giutaraldehyde (final concentration), were taken from all depths from all level one CTD casts for the determination of bacterial numbers by image analysis.

Additional samples

At each depth sampled for either primary or bacterial production rates, the following complementary samples were taken for laboratory analysis:

a. 60ml sample preserved with Lugol's iodine for the enumeration and identification of phytoplankton, heterotrophic nanoplankton and dinoflagellates, and ciliates.

b. 60ml sample preserved with 2% e.m. grade glutaraldehyde for the determination of bacterial and nanoflagellate numbers by image analysis, and for the preparation of samples for scanning electron microscopy, if required.

c. 1 litre sample filtered through a GFF filter paper for the spectrophotometric determination of total chlorophyll.

d. 100ml sample filtered sequentially through 5,1 and 0.2 µm polycarbonate filters for the fluorometric determination of chlorophyll in each of the size fractions used in the *in-situ* primary production incubations.

***Table 5.3.1**: Experiments carried out*

Date	*In-situ* ^{14}C	Thymidine uptake	Total chlorophyll	Fractionated chlorophyll	Lugols	Glut
28.5	Y	Y	Y	Y	Y	Y
29.5	Y	Y	Y!	-	Y	Y
30.5	-	Y	Y	Y	Y	Y
31.5	-	-	-	-	-	-
1.6	Y	Y	Y	Y	Y	Y
2.6	-	Y	Y	Y	Y	Y
3.6	Y	-	Y	Y	Y	Y
4.6	Y	Y	Y	-		
5.6	Y	Y	Y	Y		Y
6.6	-	-	Y	Y	Y	Y
7.6	-	-	-	-	-	-
8.6	Y	Y	Y	Y	Y	Y
9.6	Y	Y	Y	-	Y	Y
10.6	-	-	-	-	-	-
11.6	Y	Y	Y	Y	Y	Y
12.6	Y	Y	Y	Y	Y	Y
13.6	Y	-	Y	-	Y	Y
14.6	Y	Y	Y	Y	Y	Y

5.4 Iron limitation of primary productivity

(Helen Chadd)

Introduction:-

My aims on cruise B2 47/90 on the RRS Charles Darwin were to determine whether phytoplankton primary productivity was due to iron limitation in the open ocean. I tried to achieve this by conducting the following experiments:-

1. Stimulation of ^{14}C uptake over 24 hrs. as a result of spiking sea water samples with iron III chloride in 0.5M Hcl.
2. Iron uptake and kinetics experiments using iron 55 as a tracer.
3. Stimulation of chlorophyll synthesis as a result of spiking with iron.
4. Collection of whole cell samples for potential antibody analysis back at Warwick.
5. Collection of cell samples for mRNA analysis back at Warwick.

Although all the experiments outlined above were achieved as yet no conclusive evidence can be given to say whether iron is or is not a limiting nutrient in this particular part of the ocean. What has become very apparent is the degree of difficulty in working with iron at sea, regarding contamination and use of ultraclean techniques.

EXPERIMENTAL TECHNIQUES.

Stimulation of ^{14}C uptake.

Nine experiments were conducted, the first three involved spiking ^{14}C inoculated sea water samples with 5nm, 10nm, 10EX2nm, 10EX3nm, $FeCl_3$ in 0.5M HCl. Radioactivity showed an increase in uptake between 5-10nm Fe with an inhibitory effect at concentrations higher than these in some cases. The iron concentrations were then lowered to an order of magnitude expected to occur in the open ocean. Experiment 4-7 involved spiking ^{14}C inoculated sea water samples with 0.25 nM, 0.5 nM, 0.75 nM, 1.0 nM $FeCl_3$ in 0.5M HCl with an acid inoculated control at each depth to determine whether the acid medium of the inoculum had any effect on ^{14}C uptake.

Experiments 8 & 9 involved spiking two C *in-situ* bottles with cold $FeCl_3$ lnm final concentration and two non ^{14}C *in-situ* bottles with ^{55}Fe lnm final concentration in order to see whether:

1) Iron uptake is depth dependent; and
2) It is possible to corrolate iron uptake with ^{14}C uptake at each depth.

N.B All samples for the following experiments were taken using a special acid washed GOFLO from Southhampton University thanks to Duncan Purdie.

^{55}Fe Uptake and Kinetics.

UPTAKE: -

A series of experiments were conducted to see if iron 55 is taken up into size fractionated marine phytoplankton samples.

1. 3 x 500ml samples inoculated with 1 nM ^{55}Fe.
2. 1 x 500ml filtered sea water sample inoc. with 1 nM ^{55}Fe.
3. 1 x 200m1 5% gluteraldehyde fixed sample inoc. with 1 nM ^{55}Fe.

100 ml samples were taken at T0 T1 T2 T4 T6 and filtered through a 1µm & 0.2µm filter. The filters were dried o/n and radioactivity counted on the tritium channel of the scintillation counter.

Results show a similar no. of CPM recorded over the 6hrs incubation.Therefore the experiment was repeated for a period of 12 hrs, all other conditions stayed as before, samples were taken at:- T0 T2 T4 T8 Tl2. Again results showed no increase in ^{55}Fe incorporation over time. This may suggest that uptake is rapid, occuring within the first hour or, alternatively over a prolonged period of time such as 24hrs.

KINETICS:-

Increasing concentrations of ^{55}Fe were used to inoculate replicate samples of sea water, concentrations ranged from 0.2- 2.0 nM ^{55}Fe, increasing in 0.2 nM intervals. After l2hrs incubation the samples were filtered thro. 1.0µm & 0.2µm filters. Filters were stored o/n in a dessicator and read the following day in the scintilation counter.

STIMULATION OF CHLOROPHYLL SYNTHESIS.

7 X 1 litre bottles were set up as follows:-

2 + $FeCl_3$ 1nm in 0.5M HCl.
2 + HCl 0.5M - determine whether inoculum medium has any effect.
2 normal seawater.
1 + $FeCl_3$ 1 nM - bottle unopened until end of experiment, control for iron contamination of other bottles during experiment.

The bottles were incubated at ^{14}C in the Gallenkamp incubator in the hold, two lights on.

Samples were taken daily for:-

Chlorophyll analysis.
Nutrient analysis.
Synechococcus cell nos.

COLLECTION OF SAMPLES FOR ANALYSIS AT WARWICK UNIVERSITY.

mRNA Analysis:-

The ability to have been able to use the SAPS in order to collect cell samples for mRNA analysis has greatly helped me speed up what would have been a long and monotonous task of filtering, which in itself is unfavourable when trying to collect samples for mRNA analysis, which has a half life of only 15 minutes. Thanks to T. Fileman & M. Gough for their time and effort with this.

Three SAPS were deployment to 10m on 29/5 & 14/6 and 15m on 2/6. Cells were collected and stored in RNA extraction buffer.

Whole Cells:-

l.5ml aliquots of whole cell suspensions - unfiltered and < lµm in size were frozen without fixing.

Iron analysis:-

1 x 60m1 bottle of filtered sea water was collected using clean techniques required for trace metal analysis. The sample was saved frozen for iron determination and possible speciation.

***Table 5.4.1**: Sample log.*

DATE	TIME	CAST NO.	DEPTH	PURPOSE
28.05.90	0415	290501	2, 5, 10, 15, 20, 25, 30, 35, 40.	PRODUCTIVITY RIG.
29.05.90	0415	290503	"	PRODUCTIVITY RIG.
29.05.90.	0400	290503	5	SEA WATER FOR IRON ANALYSIS.
29.05.90.	1600	290511	10	SAPS FOR mRNA.
30.05.90.	0415	300503	2, 5, 10, 15, 20, 25, 30, 35, 40.	PRODUCTIVITY RIG.
01.06.90	0430	010602	"	PRODUCTIVITY RIG.
02.06.90.	2100	020608	15	SAPS FOR mRNA.
03.06.90.	0415	030603	2, 5, 10, 15, 20, 25, 30, 35, 40.	PRODUCTIVITY RIG.
04.06.90.	0400	040604	"	PRODUCTIVITY RIG.
05.06.90.	0415	050604	"	PRODUCTIVITY RIG.
06.06.90.	0400	060604	"	PRODUCTIVITY RIG.
08.06.90.	0415	080601	"	PRODUCTIVITY RIG.
09.06.90.	1000	090608	25	CLEAN GOFLO ^{55}Fe UPTAKE/KINETICS.
11.06.90.	1000	110608	10	CLEAN GOFLO ^{55}Fe UPTAKE 1.
12.06.90.	0700	120604	10	CLEAN GOFLO ^{55}Fe UPTAKE 2.
13.06.90.	0415	130603	2, 5, 10, 15, 20, 25, 30, 35, 40.	PRODUCTIVITY RIG.
13.06.90.	0500	130603	10	CLEAN GOFLO ^{55}Fe UPTAKE 3.
14.06.90.	0415	140604	2, 5, 10, 15, 20, 25, 30, 35, 40.	PRODUCTIVITY RIG.
14.06.90	0500	140604	10	CLEAN GOFLO ^{55}Fe KINETICS.
14.06.90.	1415	140611	10	SAPSFOR mRNA.

5.5 Molecular biology of cyanobacteria

(Mike Wyman)

Water samples were obtained and prepared for analysis as indicated in the station list which appears as an annexe to this report. The focus of most of the sampling work was the extraction of either DNA or RNA from phytoplankton for molecular analysis on shore.

Daily samples (10-30 litres) were taken from the thermocline for subsequent analysis of *Synechococcus* population structure/dynamics. Isolated DNA will be examined for RFLPs (Restriction Fragment Length Polymorphisms) using a catalogue of cloned genes isolated previously from laboratory cultures and natural populations. In addition, similar sample volumes were processed in order to extend the range of 'natural' probes available using shotgun cloning and PCR (Polymerase Chain Reaction) techniques.

A number of *Synechococcus* samples (5-15 litres) were collected for quantitative analysis of transcriptional activity by Northern slot blotting. Genes of interest include cpeB; psbA; glnA and narB. Ribosomal RNA content will be assesed using similar techniques and *in-situ* hybridization. Difficulties with rapid processing experienced in the early part of the cruise led to the deployment of SAPs on two occasions in order to increase the amount of material available for analysis. Provided minor modifications to the top hat can be carried out to allow the collection of fractionated samples, SAPs provide the method of choice for future sampling in productive waters.

The abundance of Synechococcus cells was determined at intervals throughout the cruise. Cell numbers (3-5 x 10^7 /litre) were greatest in the mixed layer and declined rapidly below the thermocline. Relatively little variability in the *Synechococcus* population was noted throughout the cruise suggesting that population growth was closely coupled with grazing. The poor performance of the Perkin-Elmer 3000 spectrofluorometer curtailed the number of planned determinations of *Synecbococcus* phycoerythrin. However, daily samples coincident with depths selected for collection of material for DNA were processed. Excitation spectra for FE emission were invariant and showed the presence of erythrobilin as the major chromophore. As noted in this region last year, urobilin rich species normally encountered in open ocean samples were apparently absent even in samples taken from below the the rmoc line.

Five diel sampling periods of net hauls for *Trichodesmium* were completed. Colonies were isolated for analysis of transcriptional activity (including nif genes), estimation of chlorophyll and phycoerythrin and on the last diel, determination of nitrogenase activity by acetylene reduction. Further samples for isolation of DNA and biochemical analysis were also collected. Four primary production experiments were conducted; three PIs using ^{14}C and two oxygen micro-Winkler titration at irradiances of 10 and 22% surface light. Both techniques Gough similar estimates of photosynthetic activity, indicating that this cyanobacterium is capable of net production in these waters. Live material for shore-based determinations of nitrogenase activity by ^{15}N was collected on 16/06/90 for transport to PML. Photosynthetic pigments were analysed on board by HPLC and spectrofluorometery. Chlorophyll a, zeaxanthin, and beta-carotene were the major pigments detected by HPLC and a urobilin-rich phycoerythrin by spectrofluorometery. Further bulk samples were collected for determination of chromo phore composition of phycoerythrin and phycocyanin at PML.

Generally, the cruise was highly productive and successful despite several failures of equipment and sampling difficulties. I should like to thank Alain Bedo for his unfailing enthusiasm and collaboration with the *Trichodesmium* project and the other members of the scientific party on board (Alan Pomroy, Emily Wood, Duncan Purdie, Tim Fileman, Mark Gough) who either carried out or assisted with a number of the experiments. Many thanks also to Peter Burkill for never (or hardly ever!) refusing to find the increasing demands on wire time which we made and Cliff Law and Nick Owens at PML for supplying acetylene et cetera mid-cruise. Thanks MAD for the bottle caps and the rest of the RVS team for their able assistance.

***Table 5.5.1**: Station List DARWIN 47 May/June 1990*

Day	Date/Time	Station No.	Description	Analysis
148	28/5 1100	280507	2x30 Go Flo	DNA/FE
148	28/5 1800	280509	CTD	FE
149	29/5 0805	290506	CTD Level 1	Cyano nos.
149	29/5 1100	290507	CTD 100m	DNA
149	29/5 1530	290511	SAP 10m	RNA
149	29/5 1830	-	non-toxic	DNA
150	30/5 0745	300505	CTD	PE
150	30/5 1100	*300509*	Go Flo	DNA/RNA
150	30/5 1205	300510	WP 200 (50m)	Tricho
150	30/5 1800	300513	CTD	PE
151	31/5 1200	310507	CTD	DNA
151	31/5 1850	310511	CTD	Light Pro
152	01/6 1130	010606	Go Flo	DNA
152	01/6 1900	-	non-toxic	DNA

153	02/6 0000	020601	WP 200 (50m)	Tri/RNA
153	02/6 0335	020603	WP 200 (50m)	Tri/RNA
153	02/6 0800	020607	WP 200 (50m)	Tri/RNA
153	02/6 0900	020608	CTD Level 1	Cyano nos.
153	02/6 1145	020609	Go Flo	DNA
153	02/6 1200	020610	WP 200 (50m)	Tri/RNA
153	02/6 1800	020612	WP 200 (50m)	Tri/RNA
153	02/6 2005	020615	WP 200 (50m)	Tri/RNA
153	02/6 2110	020616	SAP B 16m	DNA/RNA
154	03/6 0005	030601	WP 200 (50m)	Tri/RNA
154	03/6 0540	030605	Prod. Rig	DNA/RNA
154	03/6 1130	030609	CTD	DNA
154	03/6 1200	030610	WP 200 (50m)	Tri/DNA
155	04/6 0230	040602	Prod. Rig	DNA/RNA
155	04/6 1145	040606	WP 200 (50m)	Tri/DNA/HPLC/PE
155	04/6 1600	040608	Go Flo	DNA
156	05/6 0000	050601	WP 200 (50m)	Tri/RNA
156	05/6 0330	050602	WP 200 (50m)	Tri/RNA
156	05/6 0745	050606	WP 200 (50m)	Tri/RNA
156	05/6 0930	050608	Go Flo	Cyano nos.
156	05/6 1019	050609	CTD Level 1	Cyano nos.
156	05/6 1200	050610	WP 200 (50m)	Tri/RNA
156	05/6 2000	050612	Go Flo	DNA
156	05/6 2015	050613	WP 200 (50m)	Tri/RNA
157	06/6 0005	060601	WP 200 (50m)	Tri/RNA
157	06/6 1210	060609	CTD	DNA
157	06/6 1230	060610	WP 200 (50m)	Tri/DNA
159	08/6 0830	080605	WP 200 (50m)	Tri/RNA
159	08/6 1205	080606	CTD	DNA
159	08/6 1225	080607	WP 200 (50m)	Tri/RNA
159	08/6 1530	080609	WP 200 (50m)	Tri/RNA/DNA
159	08/6 1930	080612	WP 200 (50m)	Tri/RNA
160	09/6 0010	090601	WP 200 (50m)	Tri/RNA
160	09/6 0340	090602	WP 200 (50m)	Tri/RNA
160	09/6 0430	090603	Go Flo	^{14}C Prod
160	09/6 0800	090607	CTD Level 1	Cyano nos.
160	09/6 1200	090610	Go Flo	DNA
160	09/6 1230	090611	Apstein 55	Cyano nos.
161	10/6 1240	100605	CTD	DNA
161	10/6 1345	100608	WP 200	Tn/DNA
162	11/6 0005	110601	WP 200	Tni/RNA
162	11/6 0320	110602	WP 200	Tri/RNA
162	11/6 0400	110602	Go Flo	^{14}C Prod
162	11/6 0800	110607	WP 200	Tni/RNA
162	11/6 1200	110609	WP 200	Tni/RNA
162	11/6 1415	110611	Go Flo	DNA
162	11/6 1600	110612	WP 200	Tni/RNA
162	11/6 2010	110616	WP 200	Tni/RNA
162	11/6 2330	110617	WP 200	Tri/RNA
163	12/6 0710	120605	Go Flo	O_2 Prod

163	12/6 0840	120608	CTD Level 1	Cyano nos.
163	12/6 2030	120612	WP 200	Tri/C2H2
164	13/6 1000	130608	Apstein 55	Cyano nos.
164	13/6 1100	130609	Go Flo	DNA
164	13/6 1200	130610	WP 200	Tri/C2H2
164	13/6 1800	130612	CTD	PS
165	14/6 0005	140601	WP 200	Tri/RNA/C2H2
165	14/6 0335	140603	WP 200	Tri/RNA/C2H2
165	14/6 0800	140607	WP 200	Tri/RNA/C2H2
165	14/6 1200	140609	CTD	DNA
165	14/6 1220	140610	WP 200	Tri/RNA/C2H2
165	14/6 1605	140612	WP 200	Tri/RNA/C2H2
165	14/6 2000	140614	WP 200	Tri/RNA/C2H2
166	15/6 0010	150601	WP 200	Tri/RNA/C2H2
166	15/6 1150	150609	Go Flo	DNA
166	15/6 1200	150610	WP 200	Tri/C2H2
166	15/6 1810	150615	CTD Level 1	Cyano nos.
166	15/6 2315	150617	WP 200	Tri/^{15}N/C2H2/^{14}C Prod/

Sample Abbreviations: DNA/RNA - nucleic acid samples for molecular analysis;
PS - phycoerythrin determinations - spectral analysis;
Cyano nos. - Cyanobacteria cell/colony counts;
Light Pro -Light Profile;
Tn - T*richodesmium* (Oscillatoria);
HPLC - Pigment profile (chiorophyll/carotenoids);
^{14}C Prod/O_2 Prod - Primary production estimations by ^{14}C and O_2 methods;
C2H2 - nitrogenase assay by acetylene reduction;
^{15}N - nitrogenase assay by ^{15}N2 incorporation.

5.6 Particulate Organic Carbon & Nitrogen and Stable Isotope & Radionucleides
(Tim Brand)

Daily casts were made for POC and PON. Depths sampled on 100m casts were 2, 10, 20, 30, 40, 60 and 100m; on Level 1 300m casts depths were 2, 10, 20, 30, 40, 50, 60, 75, 100, 150, 200 and 300m; and on Level 1 Deep casts depths were 400, 500, 600, 700, 800, 1000, 1200, 1500, 2000, 2500, 3000 and bottom. All samples were filtered through 200 µm mesh prior to filtration through pre-combusted GFF 25 mm filter pads.

***Table 5.6.1**: Sampling for POC & PON*

CAST	DEPTH	SAMPLE CHADD
280504	100	460-466
290506	300L1	467-478
290512	btmLl	479-499
300506	100	491-498
310505	100	500-507
010605	100	508-515
020608	300L1	516-528
020611	btmLl	529-541
030606	100	542-549
040605	100	550-557
050609	300L1	418-430
050611	btmLl	431-442
080604	100	443-450
090607	300L1	558-570
090612	btmLl	571-579
100602	100	580-587
110605	100	588-594
120608	300L1	595-607
120610	btmLl	608-616
130606	100	617-624
140606	100	625-632
150603	100	633-639
150615	300L1	640-652

Nitrogen Stable Isotope Sample Casts

Water samples were collected from the mixed layer and within and just below the thermocline and filtered through pre-combusted GFF filter pads for later determination of stable isotopic concentrations of nitrogen at UCNW. All samples were filtered through 200 µm mesh and from the upper three depths of each cast samples from the <5µm fraction were also taken.

***Table 5.6.2**: Sampling for stable isotopes*

CAST	DEPTHS SAMPLED
280509	5, 15, 25, 30, 35, 40, 60
300513	"
010609	"
030612	25, 30, 35, 40, 60
060611	5, 15, 25, 30, 35, 40, 60
080606	5, 15, 25, 30, 35, 40, 60
100609	5, 15, 25, 30, 40, 45, 55, 65
130612	5, 15, 25, 30, 35, 45, 55
140613	5, 15, 25, 30, 40, 45, 50, 60, 70

$^{210}Po/^{210}Pb$ Radionuclide Sample Casts

Large water samples (approx 201) were taken to determine the alpha activities of ^{210}Po and ^{210}Pb from the particulate and dissolved states of the water columnn. The particulate fraction was collected on 0.45 µm Asypore filters and the dissolved fraction was precipitated out using acidified APDC complexing agent and then collected on CFD filter pads.

***Table 5.6.3**: Sampling for Polonium and Lead radionuclides*

CAST	DEPTHS SAMPLED
280511	2, 1000, 1500, 2000, 2500, 3000, 3500
310506	2, 25, 50, 100, 350, 500, 750
030608	"
060608	"
130611	"
150616	1000, 1500, 200, 2500, 3000, 3500

^{234}Th Radionuclide Samples

Three polypropylene filter cartridges were fitted in series to the on-line non toxic sea water supply. The first cartridge filtered particulates from the supply and the second and third, which had been previously coated in manganese dioxide, extracted dissolved metal ions from the water. The gamma activity of ^{234}Th from both fractions will be analysed at EUDG.

***Table 5.6.4**: Sampling for Thorium radionuclides*

Filters	Loc.Start	Loc.Finish	Time Start	Time Finish	Volume Filtered
1 A,B,C	48 28.2N 17 28.2W	48 26.6N 17 25.4W	16.35 27/5	16.05 28/5	2588.2
2 A,B,C	48 26.6N 17 25.4W	48 21.4N 17 27.6W	16.30 28/5	17.56 29/5	2619.2
3 AB,C	48 21.4N 17 27.6W	48 24.914 17 10.9W	18.00 29/5	15.19 30/5	2445.4
4 A,B,C	48 24.9N 17 10.6W	48 22.2N 17 11.0W	17.38 30/5	18.36 31/5	3512.2
5 A,B,C	48 22.2N 17 11.0W	48 12.1N 16 59.8W	18.49 31/5	18.50 1/6	2727.8
6 A,B,C	48 11.8N 16 59.7W	47 58.2N 16 51 5W	19.30 1/6	17.26 2/6	2174.2
7 A,B,C	47 58.2N 16 51.6W	47 49.6N 16 45.4W	17.38 2/6	16.06 3/6	3361.2
8 A,B,C	47 49.5N 16 45.5W	47 38.1N 16 33.7W	16.20 3/6	16.50 4/6	3786.2
9 A,B,C	47 38.6N 16 33.6W	47 35.0N 16 20.9W	17.10 4/6	23.14 5/6	4199.2
10 A,B,C	47 34.9N 16 20.9W	47 29.4N 16 03.9W	23.28 5/6	18.21 6/6	3256.4
11 A,B,C	47 19.9N 15 45.4W	47 02. 3N 15 26.2W	20.30 8/6	16.50 10/6	5811.0
12 A,B,C	47 02.6N 15 26.2W	46 54.7N 15 26.0W	17.20 10/6	18.35 11/6	3991.4

13 A,B,C	46 54.8N 15 26.2W	46 30.9N 15 49.1W	19.00 11/6	17.40 12/6	3299.6
14 A,B,C	46 30.8N 15 49.4W	46 10.8N 16 14.6W	18.00 12/6	19.05 13/6	4245.6
15 A,B,C	46 11.0N 16 15.1W	46 03.7N 16 28.2W	17.30 13/6	19.30 14/6	3746.8
16 A,B,C	46 03.5N 16 28.2W	46 08.4N 16 37.2W	20.00 14/6	19.43 15/6	4073.0

5.7 Inorganic Nutrients

(Bob Head)

All measurements were made by discrete analysis of nitrite, nitrate, reactive silicate, phosphate and ammonium using a Chemlab based autoanalyser system, as on the North Sea program. During the period spent on station from 28 May to 15 June, daily routine nutrient samples were taken from the 0400 30 litre Goflo casts (at depths of 2, 5, 10, 15, 20, 25, 30, 35, 40 and 75m) and from the 0600 CTD profiles (at depths of 5, 10, 20, 30, 40, 50, 60, 75, 100, 150, 200 and 300m). Twice weekly Level-1 measurements (tuesday and saturday) were taken from two casts shallow to 300m (depths as per the 0600 CTD cast) and deep to bottom minus 100 metres (depths of 400, 500, 600, 700, 800, 1000, 1200, 1500, 2000, 2500, 3000 and bottom - 100m). During the latter part of the time spent on station the deep cast was restricted to 2000m (nine depths) owing to problems with the spooling on the CTD winch. One problem was noted on the shallow level-1 cast of the 9th June, CTD096/C07 when the values of the supposedly 300m sample (bottle no 1) Gough nutrient concentrations identical to the surface sample in bottle 12. The inference is that the first bottle fired was in fact no 2.

Water samples were also supplied from microzooplankton experiments (E Edwards), iron enrichment experiments (H Chadd) and stable isotope CTD casts (T Brand) for analyses. All CTD and Goflo bottle samples were drawn unfiltered into polythene or polycarbonate 60m1 bottles and each sample was analysed in triplicate within six hours of collection. All other samples were analysed in triplicate out of bottles supplied by the experimenters (see Table 5.7.1 for sample list).

Two intercalibration exercises were carried out with DISCOVERY 191 and 192 on 29th May and 12th June. The exercise on 29 May was carried out on water from Discovery station 12079 # 3 at depths of 2, 5, l0, 15, 25, and 35m, together with appropriate standards.The intercalibration on 12th June was carried out on simultaneous Level-1 CTD casts on both ships at 30, 40, 50, 60, 75, 100, 150, 200 and 300m. Primary standards were supplied by both vessels and both sets of samples and standards were analysed simultaneously.

Preliminary Results

1) Intercalibration Exercises

A provisional summary of data from the two exercises is shown in Table 5.7.2.

a) 29th May :the two sets of data show reasonable agreement except for the silicate analyses where the Darwin values are consistently lower by ca lim. This may be partly explained by the analyses being carried out >24 hours after the water was drawn from the CTD bottles.

b) 12th June :the provisional data available at this time show Chadd agreement between the two analytical systems and the two CTD profiles.The two standard sets Gough very similar analytical factors.

2) Provisional results

A summary of nutrient concentrations expressed as µmoles/l found in the top mixed layer is tabulated in table 5.7.3. Typical values found were 0.2 -0.4 µM NO_3, 0.5 - 0.8 µM SiO_3 and 0.1 - 0.2 µM PO_4. Much higher values were observed over the period 6 - 9 June (coinciding with an increase in surface salinity =0.l and a decrease in surface temperature =0.2°C) when both Nitrate and Silicate levels increased to >1 µM.

Although figures for ammonia are given, the replicates showed a wide range of variation giving concern about the accuracy of these results. The variation is probably due either to contamination or the presence of zooplankters in the samples.

***Table 5.7.1**: List of Nutrient Samples*

Date	Routine Sampling		Level-1	Experimental		
28/5	GFK(9),	CTD 285/C04(12)		MIZ(4)		
29/5	GFK(10),	CTD 295/C05(12)	CTD 295/C06(12)	MIZ(4)	SI(7)	
			CTD 295/C10(12)			
30/5	GFK(10),	CTD 305/C05(12)				
31/5		CHADD 3l5/C05(l2)			SI(7)	
01/6	GFK(10),	CTD 0l6/C05(12)		MIZ(4)		
02/6	GFK(10),	CTD 026/C06(12)	CTD 026/C08(12)	MIZ(4)		
			CTD 026/C09(12)			
03/6	GFK(9),	CTD 036/C06(12)		MIZ(4)	SI(7)	FE(1)
04/6	GFK,(10),	CTD 046/C05(12)		MIZ(4)		FE(6)
05/6	GFK(11),		CTD 056/C09(12)	MIZ(4)		FE(6)
			CTD 056/C11(12)			
06/6	GFK(10),	CTD 066/C06(12)		MIZ(4)	SI(7)	FE(6)
08/6	GFK(10),	CTD 086/C04(12)		MIZ(4)		FE(6)
09/6	GFK(10),		CTD 096/C07(12)	MIZ(8)		
			CTD 096/C12(9)			
10/6	GFK(10),	CTD 106/C02(12)		MIZ(4)	SI(8)	FE(8)
11/6	GFK(10),	CTD 116/C06(12)		MIZ(4)		
12/6	GFK(10),		CTD 126/C08(12)	MIZ(4)		FE(6)
			CTD 126/C09(9)			
13/6	GFK(10),	CTD 136/C06(12)		MIZ(8)		FE(6)
14/6	GFK(10),	CTD 146/C06(12)		MIZ(8)	SI(9)	FE(6)
15/6		CTD 156/C03(12)	CTD 156/C15(12)			FE(7)

Notes: GFK - Goflo bottles, Kevlar winch
MIZ - Microzooplankton
SI - Stable Isotope cast
FE - Iron enrichment experiment
Numbers in parenthesis equals numbers of samples taken for analysis.

***Table 5.7.2**: Nutrient Intercalibration Data on 29th May and 12th June 1990*

DATE	DEPTH	NO_2*	NO_2**	NO_3*	NO_3**	PO_4*	PO_4**	SiO_3*	SiO_3**
29/5	2	0.05	0.11	0.90	0.81	0.03	0.08	1.59	0.61
	5	0.05	0.22	0.76	0.86	0.03	0.08	1.60	0.61
	10	0.05	0.22	0.91	0.87	0.03	0.08	1.63	0.61
	15	0.05	0.11	0.91	0.81	0.03	0.08	1.59	0.56
	25	0.09	0.14	1.06	0.78	0.06	0.11	1.70	0.70
	35	0.52	0.76	6.19	5.55	0.41	0.36	3.18	2.35
12/6	30	0.17	0.23	2.02	1.99	0.19	0.28	0.83	0.96
	50	0.40	0.45	8.01	7.97	0.39	0.56	2.20	2.84
	100	0.05	0.09	9.95	9.57	0.56	0.64	3.60	4.12
	300	0.30	0.09	10.05	10.83	0.29	0.74	4.35	4.52
				(DARWIN CTD)					
0	0.04	0.09	0.30		0.14	0.14	0.15	0.73	0.72
0	0.39	0.36	3.80		3.80	0.29	0.39	1.15	1.22
	100	0.05	0.09	10.00	9.59	0.56	0.64	3.55	3.82
	300	0.04	0.10	11.80	10.96	0.69	0.74	4.33	4.63
				(DISCOVERY CTD)					

Notes: * - Discovery autoanalyser
** - Darwin autoanalyser
Results for 12/6 are only provisional via R/T,depths compared were 30, 40, 50, 60, 75, 100, 150, 200 and 300m. All results are expressed as Imoles/litre.

***Table 5.7.3**: Nutrient Concentrations in the Top Mixed Layer*

DATE	TEMP °C	NO_2	NO_3	PO_4	SiO_3	NH4
28/5	14.706	0.05	0.21	0.12	0.50	0.86
29/5	14.851	0.05	0.36	0.22	0.67	1.60
30/5	15.260	0.06	0.46	0.09	0.45	N/A
31/5	14.954	0.09	0.33	0.18	0.66	1.13
01/6	14.502	0.05	0.65	0.19	0.67	1.00
02/6	14.875	0.07	0.36	0.13	0.48	N/A
03/6	15.193	0.06	0.38	0.19	1.08	0.41
04/6	15.206	0.17	0.40	0.12	0.77	0.27
05/6	14.961	0.08	0.54	0.16	0.99	0.44
06/6	14.818	0.08	1.33	0.19	0.96	0.29
08/6	14.949	0.10	0.90	0.15	0.84	0.18
09/6	15.082	0.07	0.40	0.13	0.76	0.34
10/6	15.429	0.06	0.15	0.15	0.79	0.19
11/6	15.305	0.08	0.23	0.14	0.67	1.05
12/6	15.433	0.07	0.27	0.13	0.77	0.36
13/6	15.323	0.12	0.45	0.12	0.77	0.36
14/6	15.897	0.08	0.35	0.18	0.87	0.63
15/6	15.569	0.08	0.38	0.10	0.66	0.49

Notes: all values expressed as µmoles/litre
Top mixed layer normally 20-40 metres deep

5.8 Organic Biomarkers in the Water Column

(Mark Gough & Tim Fileman)

INTRODUCTION

This collaboratorive research project between PML and the University of Liverpool has as a principal aim the utilisation of organic molecular "biological marker" compounds to identify and quantify the sources, transformation pathways, fluxes and fates of organic carbon in the North East Atlantic. The initial phase of this research (1989) focussed upon the distribution of terrestrially -derived lignin and marine derived photosynthetic pigment "biological markers" in surficial sediments, suspended particulates, and sediment trap material sampled from stations located along the 20°W transect. This year's Lagrangian study has focussed upon temporal changes in the composition of upper mixed layer pigments during the development of the spring bloom, and on the vertical flux of organic matter out of the euphotic zone.

SAMPLING

Time Series:
The composition of upper mixed layer photosynthetic pigments at 10 and 30m was determined by filtration of water sampled by GOFLO or CTD. Casts were made twice daily at ca. 0600 and 1800, 1-2L of water was filtered through 25mm GF/F filters, and the samples stored frozen until analysis by shipboard HPLC.

Level 1 casts:
Vertical profiles of pigments were obtained on shallow level 1 casts by filtration of 21, water samples at 12 depths (2, 10, 20, 30, 40, 50, 60, 75, 100, 150, 200, 300). Samples were stored frozen and await analysis in the laboratory. An additional three profiles of subsurface pigments were sampled by filtration of up to 6L of water, for accurate quantitation of carotenoid markers. A single cast of ten bottles down to 100m was made for biopolymer analyses by pyrolysis GC-MS.

Size Fractionated Pigment Distribution:
Samples of 10m and 30m water were filtered sequentially through 5, 1, and 0.2µ nuclepore filters to determine the distribution of pigments amongst various size fractions of the algal community. Samples were stored frozen and await analysis in the laboratory.

Underway Sampling:
A total of 12 1-2L non toxic water samples were collected during passage to and from the station. These samples will provide an indication of the onshore/offshore gradient in pigment composition, will serve as a calibration for the *in-situ* flow through fluorometer, and will provide "sea truth" data for correlations with satellite imagery.

Stand Alone Pumps:
Suspended particulates were collected by *in-situ* filtration using stand alone pumps at depths ranging from 10m to 4,500m. A total of 28 casts of up to six pumps provided particulates which were subsampled and distributed amongst several investigators for a variety of analyses. These include pigments, POC/PON, biopolymers (Gough, PML); lipids (Conte, U. Bristol); stable isotopes (Kennedy, UCNW); and radionuclides (Shimmeld). Additional casts were made for molecular biological analyses (Wyman/Chadd). Two further casts (12 depths) to 1,000m were subsampled for proteins, carbohydrates, lipids, biopolymers, pigments, and POC/PON; analyses for these will be performed at PML. This will provide a more coherent appraisal of carbon cycling in the upper open ocean water column.

b) Particle Pulse Experiment:
Repeat sampling of particulates by *in-situ* filtration at two depths over a 48 hour period was performed to assess the effect of diurnal variability on the upward/downward flux of molecular organics. Pumps were situated at preset depths (20m and 70m below the fluorescence maximum) and timed to pump at 6 hour intervals. Filters were subsampled as described above.

PRELIMINARY RESULTS HPLC

A total of 72 samples of 10 and 30m filtered particulates were analysed by ship board HPLC during cruise 47/90. Preliminary 10m chlorophyll a concentrations obtained from fluorescence chromatograms showed levels of the order of 1.2-1.9 µg/l during the first week, decreasing steadily to values 0.5-0.9 µg/l at the end of the time series. 30m values were generally lower and more variable between casts. Qualitative accessory pigment compositions varied little during the study period, and the chromatograms were dominated by chlorophyll c3, l9-butanoyl- and 19-hexanoyl- esters of fucoxanthin (indicative of prymnesiophytes); chlorophylls Cl and C2, fucoxanthin, diadinoxanthin (typically recognised as being diatom derived), peridinin (dinoflagellates) and chlorophyll b/lutein (chlorophytes). Some doubt was expressed as to the noted absence of zeaxanthin, a potential marker for cyanobacteria, although absolute confirmation will be provided by diode array spectroscopy at PML. Methods of resolving lutein/zeaxanthin will also be investigated for accurate quantitation. Values of chlorophyll a observed during the time series experiment are shown in Table 5.8.1.

Stand Alone Pumps
A total of 28 casts of stand alone pumps were performed on Darwin cruise 47/90, obtaining 89 samples of suspended particulates, and filtering a total volume of 67,947 L of water (see log sheets). However, considerable problems were encountered with filter ruptures, presumably caused during the passage of pumps through the water on deployment and/or during periods of heavy swell. Despite many attempts to solve this problem (e.g. by use of two filters, efficient priming, top hat modifications, meshes), filters would still shred. Such problems were not encountered on last years cruises, it therefore appears that the new design of the Challenger Oceanic filter housings is the main cause. We recommend that Challenger Oceanic fully investigate this problem, with open ocean sea trials, and perform modifications free of charge. In addition, the internal structure of the filter base and coupling to the pump unit needs modification to ensure even particle distribution on the filter for representative subsampling. Challenger Oceanic will be informed on our return to Plymouth.

ACKNOWLEDGEMENTS

Many thanks to the officers, crew, and scientists on board Darwin 47/90 for all their help and for making the cruise so successful. We particularly thank Tim Brand for help with the SAPs, and Peter Burkill for excellent organisation and for providing sociable slots in the program.

***Table 5.8.1**: Chlorophyll-a concentrations measured by HPLC with fluorescence detection.*

DATE	TIME	CAST	10M	30M
28/05/90	0930	28/05/05	1.463	1.315
	1800	28/05/09	1.576	1.208
29/05/90	0600	29/05/05	1.872	1.184
	2230	29/05/12	0.958	0.229
30/05/90	0740	30/05/06	1.386	1.620
	1800	30/05/13	1.371	0.342
31/05/90	0730	31/05/05	1.135	1.037
	1800	31/05/11	1.502	0.262
01/06/90	0720	01/06/05	1.735	1.076
	1820	01/06/09	1.860	0.773
02/06/90	0620	02/06/06	1.640	0.810
	1910	02/06/14	1.519	0.812
03/06/90	0600	03/06/06	1.265	1.099
	2100	03/06/12	1.188	0.840
04/06/90	0630	04/06/05	1.068	0.242
	1810	04/06/09	0.821	--
05/06/90	0830	05/06/07	1.135	1.086
	2000	05/06/14	1.068	1.238
06/06/90	0700	06/06/06	1.346	1.148
	2000	06/06/16	1.347	1.166
08/06/90	0700	08/06/04	1.226	0.916
	1800	08/06/10	0.889	1.091
09/06/90	0800	09/06/07	1.078	0.663
	1700	09/06/13	1.250	0.387
10/06/90	0620	10/06/02	1.030	0.698
	1830	10/06/09	1.102	0.938
11/06/90	0640	11/06/05	0.969	0.783
	1845	11/06/13	0.662	0.530
12/06/90	a.m	12/06/08	0.884	0.502
	1930	12/06/11	0.888	0.686
13/06/90	0730	13/06/06	0.854	0.378
	1800	13/06/12	0.571	1.017
14/06/90	0630	14/06/06	0.732	0.639
15/06/90	0630	15/06/06	lab	0.980
	1810	15/06/14	0.440	0.800

5.9 Flow Cytometric Analysis of Particulates

(Glen Tarran & Peter Burkill)

VERTICAL PROFILES

Samples taken from the CTD 300m, "Level 1" 300m and "Level 1" deep casts were processed at regular intervals to obtain information on the particulate community in the 2-11 µm size range. The following cytometric measureemnts of particles were made:

- Log Forward Angle Light Scatter (LFALS) was obtained for abundance and size of particles,
- Log Coulter Volume (LCVA) for particle volumes,
- Log Integral Red Fluorescence (LIRFL) and Log Integral Green Fluorescence (LIGFL) for cellular chlorophyll and phycoerythrin content respectively.

To determine the volume of sample aspirated, a known number of 9.33µm spheres were added to each sample. In addition, fluorescein standard spheres were run along with an algal culture of *Dunaliella* for calibration of the LIRFL with chlorophyll. The *Ounaliella* was analysed quantitatively for pigments using HPLC.

In the first week, technical difficulties due to electrical interference of LFALS and LCVA were found. It will, however, be possible to rectify the spurious counts back in the laboratory when the data is analysed in detail. The LIRFL and LIGFL signals were not affected.

The overall vertical structure of the water column remained relatively constant throughout the cruise. Isometric plots of LFALS versus LIRFL showed typical distributions with fluorescence decreasing with depth. As the cruise progressed red fluorescing particles penetrated down to 50m after initially being confined to the upper 30m during the first week. The information on particles containing both red and green fluorescence was fairly constant all through the cruise. Particles in the top 30-50m contained very little green fluorescence but exhibited variable amounts of red fluorescence.

The proportion of non-fluorescent particles increased with depth down to 3000m.

The total number of particles decreased over the period of the cruise by about a third of original numbers. It is possible that the decline in numbers has been mainly in the smaller sizes as a peak at about 6 or 7 µm began to appear during the latter part of the cruise. It is unclear whether the counts for the first week in their present form are valid owing to the problem of electrical noise.

DILUTION EXPERIMENTS

To assess the utility of AFC in the measurement of uticrozooplankton grazing, parallel experiemnts were undertaken with Elaine Edwards. Duplicate samples from the 100%, 70% and 40% unfiltered seawater bottles in a dilution experiment were analysed on the cytometer. A primary analysis of the data showed that grazing had taken place at all dilutions in terms of numbers. In addition, red fluorescence tended to decrease whereas green fluorescence increased. Further analysis data is required to successfully interpret the data.

TROUBLESHOOTING

1. CVA Data Output

There were, during the course of the cruise a number of technical problems associated with the running of the Coulter CVA system. Only one aspect, the actual presentation of the data in the form of histograms may have been as a result of shipboard interference. The collection of data as 2 parameter histograms with LFALS on the X-axis and LCVA-on the Y-axis produced unexpected results. Throughout the cruise a tight population of particles running from approx. a third of the way up the Y-axis and stretching out horizontally was observed. Tests using calibration spheres and also running sheath alone at different potentials and gains produced the same result. I believe the counts were real but the way in which they were interpreted by the CVA and consquently the MDADS were incorrect. One final check needs to be done when the cytometer is back in the lab. Samples will be run as before to see if the problem was due to shipboard interference.

2. Moisture In CVA

At one point the fault light would not extinguish, indicating moisture in the system. Although the correct remedial procedures were carried out nothing happened. Bob Spencer from Coulter was contacted and said that it was possible that it might well take many hours to dry out, not a point outlined in the manual. As time was at a premium a decision was taken to disconnect the CVA and isolate the problem. Moisture was found in the tube running from the multi-chamber to the containment filter at the rear of the CVA, triggering the moisture sensor en route. The source of this water was thought to be waste from T2 of the flow cell sputtering into the multi-chamber under pressure. In order to continue running the cytometer the moisture sensor was disconnected as it was considered that small amounts of moisture exiting via the containment filter were not going to cause any damage to the CVA.

3. CVA Shutting Itself Down

Following problem 2 there came a time when the CVA would shut off and the 'ready' light would illuminate. A temporary solution was to press 'run' and 'shutdown' or 'recycle' together and let the system flush through. However, after a while this would not work and the system would not advance from 'ready'. The CVA was disconnected and the multi-chamber was found to be full of water. It transpired that the problem was that the air filter on the vacuum 1 jar was old and clogged resulting in zero vacuum. This did not, however, solve the problem, it only found the original cause. The pressure sensor attached to the multi-chamber had become wet and was inoperable. When disconnected the CVA functioned normally.

4. Nitrogen Leakage

Nitrogen was found to be leaking badly from the cytometer, the cylinder regulator having been checked. After checking the hoses in the pneumatics drawer the leakage was isolated to the solenoid attached to the CVA pressure regulator in the drawer. A replacement was sent for via the RRS Discovery. In the event it was not required as the cytometer was attached to the ship's own compressed air supply by Duncan Anderson (Chief Engineer), bypassing the need for nitrogen cylinders.

5. Laser Failure

Mid-way through the cruise the laser unexpectedly shut off loudly, tripping the earth leakage breakers. The laser cover was removed and the red high tension lead connected to the starter coil was badly charred. The ship's Electrical and Chief Engineers (Phil Parker and Duncan Anderson) spent the next two days along with liaison from Coulter's Wayne Reese isolating and rectifying the problem and repairing the damage done to the laser. In order to continue using the cytometer the laser interlock had to be permanently defeated. During the course of their work the engineers discovered that many of the

connections within the laser were loose, including the connection between the red MT lead and the starter coil.

6. Electrical Noise

The position of the DC cable attached to the flow cell was causing a great deal of noise on the baseline of the LFALS axis, Moving the cable removed the noise but also put the alignment of the flow cell out. The point at which the cable attaches to the flow cell bends rather a lot and is not particularly suitable for such a delicately aligned piece of equipment (flow cell).

NOTE: In essence too much of the CVA system depends on the multi-chamber which, when wet could take days to dry out before the sensors switch off. The chamber itself seems to be too simplistic in design with the basic fault that it doesn't seal and so if it floods electrolyte pours all over the system.

The reference manual is far too non-specific for trouble shooting. It is suggested that a a more comprehensive Chadd be produced and/or engineering courses be run in conjuntion with basic operational courses for operators using systems such as the EPICS where access by field engineers is impossible e.g. at sea.

Video Recording Of Live Samples

A black and white U-matic video system belonging to PML was taken on the cruise and connected to an Olympus IMT-2 inverted microscope. Three Apstein net hauls (net mesh 20 µm) were taken during the cruise from 35m to the surface. A total of approx. 1h 20min. of recordings were made of tintinnids, naked ciliates, nanoflagellates and dinoflagellates swimming and grazing. It was interesting to note that the resolution of the camera exceeded that of the x40 microscope objective.

5.10 MICROZOOPLANXTON TROPHODYNANICS

(Elaine Edwards & Peter Burkill)

AIMS:

1. To quantify herbivorous activity by microzooplankton and to determine the principal grazers in the surface mixed layer.
2. To determine the micro zooplankton biomass and size distribution in vertical profiles of the surface mixed layer.

Profiles were sampled and rate measurements made on alternate days during the 20 days on station, resulting in a total of 10 grazing experiments and 12 profiles, 4 of which were for level 1 measurements. A summary of all sampling details is given in Tables 5.10.1, 2 & 3.

METHODS

Grazing

Dilution experiments were carried out using the approach of Landry & Flassett (1982). Water was collected from 30-litre GoFlo bottles from either 10 or 25m at dawn, and was gently screened through a 200 µm mesh. Microbial communities were diluted out to 100%, 70%, 40% and 10% concentrations in 2 litre bottles which were incubated at simulated ambient light and temperature levels for 24 hours. Samples were taken at 0, 12 and 24 hours for determination of chlorophyll concentration, nutrients, abundance,

trophic composition and biomass. Size-fractionated chlorophylls were taken for half of the experiments using polycarbonate membrane filters of pore sizes, 0.2, 2 and 10µm. Sub-samples from 100%, 70% & 40% dilutions were analysed on the flow cytometer at T 0 and T 24.

Bead-uptake experiments were carried out to determine which microzooplankton organisms were actively grazing. Fluorescent 1, 4 and 9 µ beads were added to natural populations which were then subsampled during short term incubations.

Biomass

Microzooplankton biomass samples were collected in conjunction with the grazing experiments. Water was collected using the CTD from 9 depths in the top 300m. These are detailed in table 2. Appropriate volumes of water were fixed in 1% acid Lugol's iodine for determination of total microzooplankton abundance, 2% glutaraldehyde for determination of nanoplankton abundance and 2% buffered formaldehyde to determine what proportion of the ciliates and dinoflagellates were plastidic/aplastidic. Samples were also preserved in glutaraldehyde, stained with DAPI and proflavin, filtered onto Nuclepore filters and stored frozen for subsequent analysis by epifluorescence microscopy. Samples will be analysed by Drs Stoecker, Sieracki. & Verity (USA) as well as ourselves, as part of JGOFS collaboration.

A series of 20 µm Apstein net hauls through the surface mixed layer were performed. Half of the sample was fixed in 1% Lugol's for qualitative analysis in the laboratory, the other half used for live microscopic observation.

RESULTS

Grazing: No results are available due to the failure of the fluorometer to function properly (despite having been recently fixed at PML). All of the analysis for the grazing experiments will be done in the laboratory. Initial results indicate that the microzooplankton were turning over 30-40% of the phytoplankton biomass each day.

Bead uptake samples will be analysed in the laboratory.

Apsteins: Microscopic qualitative analysis of live Apstein samples indicated that there was a change in species composition throughout the duration of the cruise. The main phytoplankton species present were *Gonyaulux, Peridinium, Ceratium,* with others such as *Oxytoxum, Coscinodiscus* and *Rhizosolenia* also present.

Living *Dictyocysta*, present throught the most of cruise 81 was not found at the start of DARWIN 47/90. There were only a few small tintinnids, but small (15 µm) *Strombidium* type ciliates were fairly abundant. Towards the second half of 82 there was a sudden increase in tintinnid numbers. The main species present being *Eutintinnus* and *Proplectella*,while *Codonellopsis, Dictyocysta* was present in small numbers. Large naked oligotrich ciliates were also evident, these were much larger than those seen in the early stages of the cruise and hopefully will be identified from fixed samples back in the laboratory. The change in species composition took place between the 6/6/90 and 10/6/90.

***Table 5.10.1**: Microzooplankton grazing experiments*

Expt No	Type	Date	Depth	Goflo Time	CTD Cast #	Time T0	Time T12	Time T24	Temp °C
13	GF/F	28/5	25m	5:45	2805/02	6:45	21:00	6:45	14.3
14	FRACT	30/5/90	25m	7:00	3004/02	8:45	20:30	9:00	12.0
15	GF/F	1/6/90	10M	6:10	0106/03	8:30	20:30	8:35	14.6
16	FRACT	3/6/90	10M	5:00	0306/02	6:00	21:30	6:00	15.2
17	GF/F	5/6/90	25m	5:45	0506/04	6:35	21:55	6:35	14.8
18	FRACT	8/6/90	25m	5:30	0806/02	6:30	20:00	6:50	n.a.
19	GF/F	9/6/90	25m	6:30	0906/05	10:45	21:30	11:0	n.a.
20	FRACT	11/6/90	10M	5:20	1106/03B	6:30	20:30	6:30	15.3
21	GF/F	13/6/90	10M	5:10	1306/04	6:50	21:00	8:20	n.a.
						8:45	21:45	8:55	n.a.
22	FRACT	15/6/90	25m	7:35	1506/05	9:00	20:30	9:00	n.a.

***Table 5.10.2**: Microzooplankton sampling by 20 µm Apstein net.*

DATE	DEPTH	TIME
27/5/90	35-0m	19:30
29/5/90	35-0m	13:51
31/5/90	35-0m	13:23
2/6/90	35-0m	18:10
4/6/90	35-0m	13:20
6/6/90	35-0m	14:40
10/6/90	35-0m	13:30
11/6/90	35-0m	20:30
13/6/90	35-0m	12:00
14/6/90	35-0m	16:05
15/6/90	35-0m	13:00

***Table 5.10.3**: Microzooplankton sampling by water bottle.*

Date	Time	Cast	Type	Depths	Sample
28/5/90	8:20	2805/04	CTD-300	9	Lugol's Glut Form Slides
29/5/90	8:00	2905/06	LEVEL 1	12	Lugol's Glut
30/5/90	7:40	3005/06	CTD-300	9	Lugol's Glut Slides
1/6/90	7:20	0106/05	CTD-300	9	Lugol's Glut Form Slides
2/6/90	9:06 12:36	0206/07 0206/11	LEVEL 1	9 3	Lugol's Glut
3/6/90	6:00	0306/03	CTD 300	9	Lugol's Glut Slides
5/6/90	10:19 12:53 FORM	0506/09 0506/11	LEVEL 1	9 3	Lugol's Glut Form Slides
8/6/90	6:40	0806/03	CTD 300	9	Lugols Glut Slides
9/6/90	8:00	0906/07	LEVEL 1	12	Lugol's Glut Form Slides
11/6/90	6:40	1106/05	CTD 300	9	Lugol's Glut Slides
13/6/90	7:40	1306/06	CTD 300	9	Lugol's Glut Form Slides
15/6/90	6:40	1506/03	CTD 300		Slides
15/6/90	18:10	1506/15	LEVEL 1	9	Lugol's Glut Form

5.11 MESOZOOPLANKTON

(Alain Bedo, Carmen Morales & Bob Head)

I Sampling Strategy

- In general, our sampling activity (cf section III) has been organized according to a 3-days scheme to allow the survey of temporal changes occuring 1) in the particulate environment, 2) in zooplankton biomass and species composition from 3 size-fractions (2000-1000 µm; 1000-500 µm; 500-200 µm) and 3) in biological rates associated with feeding (i.e. ingestion, digestion and egestion rates).

DAY 1
- Zooplankton biomass assessment in the 0-100m layer
- Particle characterization in terms of size distribution (as determined by Coulter Multisizer II) and biochemical composition (Carbon, Nitrogen, Soluble/Insoluble Carbohydrates, Proteins/Amino-acids, Total Chla and >5 µm chl-a).

DAY 2
- Feeding studies including shipboard experiments (determination of ingestion rates and evacuation rates; collection of fecal pellets).

DAY 3
- 24 hrs survey of Chadd pigment content of herbivorous copepods (every 4 h sampling) in the 3 size-fractions. From the small size-fraction replicate samples have been taken for phycoerythrin determinations, as a potential index of feeding on Cyanobacteria. The diel sampling also included collection of the filamentous Cyanobacteria *Trichodesmium sp* as part of a collaboration with Dr Wyman (Details are given in Section 5.5).

- 3 sets of data have been collected on a daily basis for our Lagrangian series throughout both B1 and B2 (Charles Darwin cruises 46/90 and 47/90) including

  1) a daily midday-midnight zooplankton sampling for determination of biomass and species composition,
  2) a daily midday-midnight zooplankton collection for determination of feeding and digestive activities as described by gut pigment content (in the 3 size fractions) and digestive enzymes levels (in the small fraction), respectively.
  3) a daily 6 or 7 depths profile (2, 10, 20, 30, 40, 60, 100 m) for particle counts and size distributions including formalin/lugol samples for cells counts and identification at 20 and 40 m.

II Preliminary Results

A. Particulate Environment

With the exception of *Trichodesmium* colonies (which are bigger than 200 µm), particle size distributions were always highly dominated by small and very small sized material (<20 and <10 µm). Still,important transformations affected the size spectra in this size range, partly associated with the decrease in total particle concentration recorded throughout B2 (Figure 5.11.1). Chlorophyll-a also decreased progressively during this period.

From 28/05 to 02/06/90 PSS were unimodal with a sharp peak around 6.25 µm; Up to 09/06, this peak progressively shifted to larger sizes (ca 8-10 µm) while a secondary peak could be more easily identified around 3.13 µm. A gradual uniformization of PSS was the main feature of the last 6 days of sampling, certainly due to the drop in particle concentration initiated on 10/06 (Figure 5.11.1).

Due to electrical noise and interferences, the peak detected around 2.0µm -(certainly associated with cyanobacteria which reached very high numbers during this cruise) - has not been properly assessed before 01/06.

B. Mesozooplankton Biomass

The abundance of mesozooplankton has sharply decreased as compared with B1 observations and this shift was accompanied by some qualitative changes in the community : among copepods *Calanus* had become a major component of the medium size fraction while *Pleuromamma sp* and *Metridia sp* were much more variable and never reached the densities observed during the first leg. Amphipods occurence (usually mainly represented by young stages) was quite variable on a daily basis but they could sometimes turn into the essential of the night catches. Gelatinous plankton abundance - (mainly siphonophores and ctenophores) - gradually decreased during the survey while Appendicularians were almost absent.

C. Mesozooplankton Feeding

Shipboard experiments run with small copepods have shown the ability of different species - with the exception of *Oithona sp* -to ingest *Synechococcus,* suggesting this route could be important for the repackaging of small particles into larger forms (zooplankton contribution to particle flux) in the water column considering the abundance of the small size classes of copepods and that of the Cyanobacteria populations.

The biomass and productivity represented by *Trichodesmium* (cf Wyman's report) must influence the secondary production since some small species of copepods (still to be identified) were found attached to the colonies, which could act as a substrate and food source necessary to their growth. But, the nutritional role of *Trichodesmium* colonies (>200 µ) for particle grazers remains unclear, as the feeding experiments performed using them as a food source for various zooplankters didn't bring any strong evidence - (through fecal pellet production) - of grazing.

***Table 5.11.1**: Mesozooplankton sampling details*

27/05/90	19.30	NETS		
		Gelnet	100 m	Appendicularians
		Gelnet	30 m(x5)	Appendicularians
	23.35	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-500	100 m	Experiment
		WP2-500	100 m	Experiment
28/5/90	09.45	CTD		
		Full profile (2, 10, 20, 30, 60, 100 m)		
		Chlorophyll, CHN, Multisizer, Lugols, Protein and Carbohydrates		
	13.15	NETS		
		Apstein-55	100 m	Biomass
		Apstein-20	100 m	Biomass
		Apstein-200	200 m	Appendicularians
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		Gelnet-200	30 m	Appendicularians
		Gelnet-200	100 m	Appendicularians
	19.00	GO FLOW		
		Water collection for experiments		
29/5/90	00.00	NETS		
		Apstein-20	100 m	Biomass
		WP2-100	100 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Appendicularians
		WP2-500	100 m	Experiment
	06.00	CTD		
		Complementary profile (Multisizer & lugols)		
	12.35	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-100	50 m	Experiment
		WP2-100	100 m	Experiment
		Gelnet	200 m	Appendicularians
		Gelnet	50 m	Appendicularians
	19.00	GO-FLOW		
		Water collection (10 m)		
30/5/90	00.05	NETS		
		WP2-200	100 m	Biomass

		WP2-200	100 m	Gut Content
		WP2-500	100 m	Gut Content
	07.40	CTD		
		Complementary profile		
		08.30	NETS	
		WP2-200	100 m	Biomass
		WP2-200	50 m	Gut Content
		WP2 -200	100 m	Gut Content
		12.00	NETS	
		Apstein-55	100 m	Biomass
		WP2-200	50 m	Biomass
		WF2-200	100 m	Biomass
		WP2-200	50 m	Gut Content
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		Gelnet	100 m	Appendicularians
		Gelnet	30 m	Experiment
	16.05	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
	20.00	NETS		
		WP2-200	100 m	Biomass
		Wp2-200	100 m	GutContent
31/5/90	00.10	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-S00	100 m	Gut Content
	03.00	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
	06.40	CTD		
		Full profile		
	12.30	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m(x4)	Experiment
		Gelnet	50 m(x2)	Experiment
	19.00	CTD		
		Water collection		
01/06/90	00.05	NETS		
		Apstein-20	100 m	Biomass
		WP2-100	100 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-500	100 m	Gut Content
	07.20	CTD		

		Complementary profile		
	12.00	NETS		
		Apstein-SS	100m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	50 m(x4)	Experiment
		CELNET	100 m	Experiment
		CELNET	50 m	Experiment
	19.00	GO-FLOW		
		Water collection (10, 30 m)		
02/06/90	00.00	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	03.30	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	06.15	CTD		
		Complementary profile		
	08.00	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	12.00	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	50 m	Experiment
	18.00	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	20.00	NETS		
		WP2-200	50 m	Experiment
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
	21.20	NETS		
		WP2-200	100 m	Experiment
		WP2-200	100 m	Experiment
3/6/90	00.05	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
		WP2-500	50 m	Experiment
		WP2-500	50 m	Experiment

	07.00	CTD		
		Full profile		
	12.00	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	200 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	50 m(x4)	Experiment
		WP2-200	15 m(x2)	Experiment
	19.00	GO-FLOW		
		Water collection (10, 15 m)		
4/6/90	00.10	NETS		
		Apstein-20	100 m	Biomass
		WP2-l00	100 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	200 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	06.30	CTD		
		Complementary profile		
	11.50	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	50 m(x4)	Experiment
		Gelnet	100-200m	Biomass
	19.00	GO-FLOW		
		Water collection (15 in)		
05/06/90	00.15	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	100 m	Experiment
		WP2-200	50 m	Experiment
	03.30	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m(x2)	Experiment
	07.50	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m(x2)	Experiment
	12.00	NETS		

		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	50 m(x6)	Experiment
	19.20	GO-FLOW		
		Water collection (15 m)		
	20.10	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m(x2)	Experiment
06/06/90	00.05	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		W22-200	100 m	Experiment
		WP2-200	50 m(x2)	Experiment
	08.25	CTD		
		Full profile		
	12.15	NETS		
		WP2-200	50 m(x6)	Experiment
	14.10	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
	19.00	GO-FLOW		
		Water collection (15 m)		
	20.30	NETS		
		WP2-200	100 m	Experiment
		WP2-200	100 m	Experiment
		WP2-200	100 m	Experiment
08/06/90	06.40	CTD		
		Complementary profile		
	08.30	NETS		
		WP2-200	100 m	Biomass
		wP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	12.00	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	50 m(x2)	Experiment

	15.30	NETS		
		WP2-200	100 m	Gut Content
		WP2-200	50 m(x2)	Experiment
	18.30	GO-FLOW		
		Water collection (20 m)		
	19.45	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m(x2)	Experiment
09/06/90	00.10	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	50 m(x2)	Experiment
	03.40	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
		WP2-200	100 m	Experiment
		WP2-200	50 m	Experiment
		WP2-200	50 m	Experiment
	07.00	CTD		
		Full profile		
	12.15	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	25 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	200 m	Biomass
		WP2-200	100 m	Experiment
		WP2-200	50 m(x2)	Experiment
		Apstein-55	100-50m	V. Profile
		Apstein-55	50-40m	
		Apstein-55	40-30m	
		Apstein-55	30-20m	
		Apstein-55	20-m	
		Apstein-55	10-0m	
	17.00	GO-FLOW		
		Water collection (10 m)		
10/06/90	00.00	NETS		
		Apstein-20	100 m	Biomass
		WP2-100	100 m	Biomass
		WP2-200	25 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	200 m	Biomass
		WP2-200	100 m	Gut Content

	06.30	CTD		
		Complementary profile		
	11.45	NETS		
		Gelnet	50 m	Experiment
		Gelnet	50 m	Experiment
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	13.50	NETS		
		WP2-200	50 m(x4)	Experiment
11/06/90	00.00	NETS		
		WP2-200	100 m	Biomass
		WP2-200	50 m	Experiment
		WP2-200	50 m	Gut Content
		WP2-200	100 m	Gut Content
	03.20	NETS		
		WP2-200	100 m	Biomass
		WP2-200	50 m(x4)	Experiment
		WP2-200	30 m(x2)	Experiment
		WP2-200	50 m	Gut Content
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
	06.30	CTD		
		Complementary profile		
	08.10	NETS		
		WP2-200	100 m	Biomass
		WP2-200	50 m	Gut Content
		WP2-200	50 m	Experiment
		WP2-200	100 m	Gut Content
	12.10	NETS		
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	50 m	Gut Content
		WP2-200	50 m	Experiment
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
	16.10	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	50 m	Gut Contents
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	19.30	GOFLO		
		Water collection (10 m)		
	20.00	NETS		
		WP2-200	100 m	Biomass

		WP2-200	50 m	Gut Content
		WP2-200	100 m	Gut Content
		WP2-200	50 m	Experiment
	23.30	NETS		
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	50 m(x2)	Experiment
		WP2-200	50 m	Gut Content
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	100 m	Experiment
12/06/90	08.40	CTD		
		Full profile		
	12.10	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	25 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	200 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m(x2)	Experiment
	20.00	GO-FLOW		
		Water collection (10 m)		
	20.15	NETS		
		WP2-200	30 m(x2)	Experiment
13/06/90	00.05	NETS		
		Apstein-55	100 m	Biomass
		WP2-l00	100 m	Biomass
		WP2-200	25 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	100 m	Experiment
	07.40	CTD		
		Complementary profile		
	10.00	NETS		
		Apstein-55	40-30m	Vertical profile
		Apstein-55	30-20m	V. profile
		Apstein-55	20-10m	V. profile
		Apstein-55	10-0m	V. profile
		WP2-200	30 m(x2)	Experiment
	12.10	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
	19.00	GO-FLOW		

		Water collection (10 m)		
14/06/90	00.05	NETS		
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	30 m(x2)	Experiment
		WP2-200	50 m	Gut Content
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
	03.35	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	30 m(x2)	Experiment
		WP2-200	100 m	Experiment
	07.00	CTD		
		Complementary profile		
	08.00	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	30 m(x2)	Experiment
	12.30	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	50 m	Biomass
		WI'2-200	50 m	Gut Content
		JP2-200	100 m	Gut Content
		WP2-200	30 M(X2)	Experiment
	16.00	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	30 m(x2)	Experiment
	20.00	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	30 m(x2)	Experiment
15/06/90	00.10	NETS		
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Lipids
		WP2-200	30 m(x2)	Experiment
		WP2-200	100 m	Experiment
	08.30	NETS		
		WP2-200	50 m(x2)	Experiment
		WP2-200	50 m(x4)	Experiment
	12.00	NETS		
		Apstein-55	100 m	Biomass
		WP2-200	25 m	Biomass

		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	200 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	50 m(x2)	Experiment
		WP2-200	30 m(x2)	Experiment
	14.05	GO-FLOW		
		Full profile		
	23.30	NETS		
		WP2-200	50 m(x2)	Experiment
16/06/90	00.00	NETS		
		Apstein-20	100 m	Biomass
		WP2-100	100 m	Biomass
		WP2-200	25 m	Biomass
		WP2-200	50 m	Biomass
		WP2-200	100 m	Biomass
		WP2-200	100 m	Gut Content
		WP2-200	100 m	Experiment
		WP2-200	100 m	Experiment

6. TECHNICAL ACTIVITIES

6.1 Computing

(Doriel Jones)

Data logging began on 25th of May at 10:50 GMT and ended at 21:05 GMT on 16th of June. Throughout the cruise, the majority of the underway data were logged successfully. However, there were hardware and software problems with the CTD level A which took some time to sort out, resulting in loss of data. These data are currently on BBC diskette, and will be forwarded in an IBM compatible format soon. Two hours of navigation data were also lost due to a failure of the Cambridge Ring which transmits data from the level A's in the plot to the level B in the computer room.

The thermosalinograph data was not calibrated correctly for the majority of the cruise. This was because it was not made clear that the interface had to be in a special mode, (9), for the raw data counts to be logged. The data therefore used the internal calibration constants, which are a little inaccurate.

Oxygen data were calibrated using the nominal salinity value of 35.6‰.

When the fluorometer on the CTD failed, the deck fluorometer was substituted. For the remainder of the cruise, there was no deck fluorometer data.

All data was archived in CF3 format at the end of the cruise.

The data logged: CPS and Transit fixes; E.M Log and Gyro; CTD; ADCP; Wave data; Thermosalinograph; IOS Met Package; Deck Light Meters, Fluorometer and Transmissometer and Fluorometer.

6.2 Instrumentation

(Andy Jones)

Technical details of the instrumentation used on the cruise are as follows:

CTD package: Neil Brown Sea Unit Mk IIIb
Model 1150 Data Terminal
Chelsea Instruments fluorometer
SeaTech 25cm transmissometer
PML PAR light sensors (2 off)
SIS Digital reversing thermometers

Deck Monitoring: Thermosalinograph model 103
Chelsea Instruments flourometer
Sea Tech transmissometer

Instrument performance

CTD:

At the start of the cruise, following a request by RVS, the Neil Brown 1150 deck unit was used. The ISG logging program couldn't handle the output from this unit, so the E, G & G 1401 deck unit was used

instead. This worked well for about one day, then the- problem of extremely noisy signal found on the previous cruise reoccurred and use of the 1150 deck unit was resumed.

Throughout the cruise, the only significant problem was with the CTD termination which failed twice due to connector damage and once due to the wire becoming caught in the spooling gear. On two occasions the wire was cropped, the continuity checked and the wire reterminated.

The only remaining problem was with the fluorometer which failed due to a slight ingress of water. It was swapped for the deck fluorometer.

TSG1O3

At the start of the cruise, the conductivity cell of the thermosalinograph read too low. Initially, the sensor was checked for marine growth and during this inspection it was noticed that the epoxy resin coating was deteriorating and peeling off. An attempt was made to reseal the area, with an apparent lack of success. Later on in the cruise, while checking the actual counts output from the interface, it was noticed that the conductivity on the local computer display rose to its correct level. A label has now been attached to the interface telling future operators to leave the interface in mode 9.

The rest of the equipment provided by SSD worked well throughout the cruise.

6.3 Mechanical Equipment

(Chris Rymer & Mike Davies)

Apart from two problems, one more serious than the other, all mechanical equipment performance was satisfactory.

The first problem was that the plastic coated wire on the Dauntless winch suffered minor damage due to spooling misalignment. In order to carry out deep casts of SAP systems (c. 4250m) it was necessary to wind shackles, etc., onto the drum for connection with the electrical conducting wire.- This, we believe, caused the spooling misalignment. In future, a more satisfactory method of connection should be used to maximise the life of the wire.

The second, more serious, problem was the CTD wire. From the start of the cruise, there were problems with the spooling of wire onto the drum. Our first cast to 4150m took several hours to complete, due to the effort needed to lay the wire correctly on the drum. However, the problem worsened after the deepest cast of the cruise, to 4950m. From previous wire log records for 29/9/89, we discovered that the spooling system had been adjusted at a depth of 4200m. This allowed the remaining wire to wind onto the drum correctly. The fact that the spooling had to be altered at this depth confirms that there is a long standing problem with the system. When continually carrying out casts to depths of over 4300m, delays and misalignment can be expected.

7. SCIENTIFIC APPENDICES

7.1 Ship's position

Day	Time (A)	Latitude (N)	Longitude (W)	Day	Time (A)	Latitude (N)	Longitude (W)
145	0632	51° 23.83'	03° 16.02'	146	1603	49° 31.39'	011° 55.14'
145	1702	51° 23.82'	03° 16.02'	146	1633	49° 30.61'	012° 03.73'
145	0732	51° 23.82'	03° 16.05'	146	2144	49° 20.47'	013° 28.95'
145	0802	51° 23.63'	03° 15.68'	146	2214	49° 18.82'	013° 37.37'
145	0832	51° 21.47'	03° 16.65'	146	2244	49° 17.18'	013° 45.71'
145	0902	51° 21.47'	03° 16.18'	147	0059	49° 10.02'	014° 23'49'
145	0932	51° 22.52'	03° 14.89'	147	0129	49° 08.36'	014° 31.62'
145	1002	51° 21.04'	03° 23.95'	147	0159	49° 06.70'	014° 39.81'
145	1032	51° 19.11'	03° 36.48'	147	0259	49° 03.28'	014° 56.57'
145	1102	51° 17.24'	03° 48.85'	147	0329	49° 01.53'	015° 05.23'
145	1132	51° 15.41'	04° 00.46'	147	0359	48° 59.73'	015° 13.97'
145	1202	51° 13.78'	04° 11.24'	147	0429	48° 57.99'	015° 22.70'
145	1232	51° 11.63'	04° 20.93'	147	0459	48° 56.13'	015° 31.48'
145	1302	51° 09.04'	04° 30.08'	147	0600	48° 52.96'	015° 49.27'
145	1332	51° 06.59'	04° 38.94'	147	0630	48° 51.53'	015° 57.96'
145	1402	51° 04.30'	04° 47.70'	147	0700	48° 49,95'	016° 06.53'
145	1432	51° 02.02'	04° 56.11'	147	0730	48° 48.30'	016° 15.15'
145	1532	50° 57.59'	05° 12.77'	147	0800	48° 46.26'	016° 23.78'
145	1602	50° 55.56'	05° 21.02'	147	0830	48° 44.15'	016° 32.34'
145	1632	50° 53.60'	05° 20.22'	147	0900	48° 41.98'	016° 40.71'
145	1702	50° 51.66'	05° 37.40'	147	0930	48° 39.79'	016° 49.09'
145	2202	50° 29.77'	07° 04.75'	147	1000	48° 37.68'	016° 57.58'
145	2232	50° 27.15'	07° 13.92'	147	1030	48° 35.84'	017° 06.00'
145	2302	50° 24.55'	07° 23.17'	147	1100	48° 34.02'	017° 14.34'
146	0102	50° 14.73'	07° 59.44'	147	1130	48° 32.01'	017° 22.77'
146	0132	50° 12.59'	08° 08.16'	147	1200	48° 29.08'	017° 30.56'
146	0202	50° 10.51'	08° 16.80'	147	1230	48° 26.48'	017° 29.37'
146	0302	50° 06.601	08° 33.01'	147	1300	48° 27.20'	017° 29.22'
146	0332	50° 04.64'	08° 41.12'	147	1330	48° 27.80'	017° 28.77'
146	0402	50° 02.73'	08° 48.99'	147	1400	48° 27.97'	017° 27.91'
146	0433	50° 00.72'	08° 56.72'	147	1430	48° 28.09'	017° 27.72'
146	0503	49° 58.59'	09° 04.46'	147	1530	48° 27.58'	017° 28.39'
146	0603	49° 55.04'	09° 20.47'	147	1600	48° 27.57'	017° 28.23'
146	0633	49° 55.94'	09° 28.38'	147	1630	48° 27.58'	017° 27.92'
146	0703	49° 54.12'	09° 36.78'	147	2130	48° 27.22'	017° 29.56'
146	0733	49° 52.59'	09° 45.50'	147	2200	48° 27.02'	017° 29.58'
146	0803	49° 50.91'	09° 54.29'	147	2230	48° 26.60'	017° 29.62'
146	0833	49° 49.11'	10° 02.97'	147	2300	48° 26.45'	017° 29.51'
146	0903	49° 47,50'	10° 11.45'	147	2330	48° 26.25'	017° 29.23'
146	0933	49° 45.99'	10° 18.75'	148	0100	48° 26.78'	017° 28.43'
146	1003	49° 49.44'	10° 25.67'	148	0130	48° 27.07'	017° 29.06'
146	1033	49° 49.44'	10° 26.02'	148	0200	48° 27.45'	017° 28.94'
146	1103	49° 49.43'	10° 30.20'	148	0300	48° 27.05'	017° 28.31'
146	1133	49° 49.42'	10° 38.84'	148	0330	48° 26.89'	017° 28.25'
146	1203	49° 40.70'	10° 47.67'	148	0400	48° 26.75'	017° 28.38'
146	1303	49° 38.92'	11° 05.09'	148	0430	48° 26.66'	017° 28.34'
146	1333	49° 37.37	11° 13.61'	148	0500	48° 26.60'	017° 28.20'
146	1403	49° 36.29'	11° 21.93'	148	0530	48° 26.52'	017° 28.13'
146	1433	49° 34.93'	11° 29.99'	148	0600	48° 26.47'	017° 28.41'
146	1533	49° 32.43'	11° 46'63'	148	0630	48° 26.34'	017° 28.58'

148	0700	48° 26,31'	017° 28.67'	149	2136	48° 20.20'	017° 25.48'
148	0730	48° 26.25'	017° 28,74'	149	2206	48° 20.07'	017° 25.45'
148	0800	48° 26.21'	017° 28.89'	149	2236	48° 19.85'	017° 25.41'
148	0830	48° 26.15'	017° 29.12'	150	0106	48° 19.67'	017° 24.49'
148	0900	48° 26.11'	017° 29.27'	150	0136	48° 19.98'	017° 24.48'
148	0930	48° 26.11'	017° 29.48'	150	0236	48° 20.70'	017° 24.12'
148	1000	48° 26.11'	017° 29.42'	150	0336	48° 21.13'	017° 23.90'
148	1030	48° 26.10'	017° 29.37'	150	0406	48° 21.49'	017° 23.59'
148	1100	48° 26.01'	017° 29.22'	150	0436	48° 24.17'	017° 21.84'
148	1130	48° 25.83'	017° 28.90'	150	0536	48° 24.52'	017° 20.50'
148	1200	48° 25.69'	017° 28.26'	150	0606	48° 24.57'	017° 19.95'
148	1230	48° 25.76'	017° 27.63'	150	0636	48° 24.67'	017° 19.23'
148	1300	48° 25.89'	017° 27.04'	150	0706	48° 24.77'	017° 18.54'
148	1330	48° 26.00'	017° 26.73'	150	0736	48° 24.88'	017° 18.10'
148	1400	48° 26.12'	017° 26.46'	150	0806	48° 25.02'	017° 17.65'
148	1430	48° 26.11'	017° 26.10'	150	0836	48° 25.14'	017° 17.40'
148	1530	48° 26.41'	017° 25.40'	150	0906	48° 25.19'	017° 16.99'
148	1600	48° 26.31'	017° 25.85'	150	0936	48° 25.16'	017° 16.68'
148	1630	48° 26.29'	017° 25.97'	150	1006	48° 25.10'	017° 16.35'
148	2135	48° 25.08'	017° 27.17'	150	1036	48° 25.10'	017° 15.89'
148	2205	48° 24.99'	017° 27.31'	150	1106	48° 25.05'	017° 15.22'
148	2235	48° 24.82'	017° 27.47'	150	1136	48° 25.16'	017° 15.16'
148	2305	48° 24.66'	017° 27.71'	150	1206	48° 25.25'	017° 14.55'
149	0105	48° 24.11'	017° 27.30'	150	1236	48° 25.26'	017° 13.89'
149	0135	48° 24.24'	017° 26.77'	150	1306	48° 25.11'	017° 13.12'
149	0205	48° 24.91'	017° 26.20'	150	1336	48° 25.03'	017° 12.26'
149	0335	48° 25.00'	017° 25.30'	150	1406	48° 24.98'	017° 11.33'
149	0405	48° 24 90'	017° 25.02'	150	1506	48° 24 68'	017° 10 25'
149	0435	48° 24.62'	017° 24.89'	150	1536	48° 24.46'	017° 09.73'
149	0505	48° 24.30'	017° 25.03'	150	1606	48° 24.16'	017° 09.15'
149	0535	48° 23.91'	017° 24.89'	150	2136	48° 22 13'	017° 04 86'
149	0605	48° 23.65'	017° 25.16'	150	2206	48° 21 98'	017° 04.54'
149	0635	48° 23.41'	017° 25.41'	150	2236	48° 21.90'	017° 04.28'
149	0705	48° 48.23'	017° 25.58'	150	2306	48° 21.71'	017° 03.88'
149	0735	48° 23.03'	017° 25.72'	151	0036	48° 21.17'	017° 02.51'
149	0805	48° 22.76'	017° 25.80'	151	0106	48° 20 92'	017° 02.05'
149	0835	48° 22.63'	017° 26.02'	151	0136	48° 20.88'	017° 01.27'
149	0905	48° 22.55'	017° 26.28'	151	0236	48° 21.01'	016° 59.08'
149	0935	48° 22 44'	017° 26.47'	151	0336	48° 20.85'	017° 08.93'
149	1005	48° 22.43'	017° 26.76'	151	0406	48° 20.78'	017° 14.34'
149	1035	48° 22.32'	017° 26,89'	151	0436	48° 21.39'	017° 19.48'
149	1105	48° 22.20'	017° 26.97'	151	0536	48° 21.76'	017° 23.16'
149	1135	48° 22.20'	017° 27.25'	151	0606	48° 21.58'	017° 23.05'
149	1205	48° 22 13'	017° 27 26'	151	0636	48° 21 30'	017° 23 04'
149	1235	48° 22.09'	017° 27.27'	151	0706	48° 21.18'	017° 23.14'
149	1305	48° 22.05'	017° 27.24'	151	0736	48° 20.77'	017° 23.25'
149	1335	48° 22.10'	017° 27.46'	151	0806	48° 20.46'	017° 23.60'
149	1405	48° 22.18'	017° 27.52'	151	0836	48° 20.19'	017° 23.74'
149	1435	48° 22.13'	017° 27.61'	151	0906	48° 19.62'	017° 23.99'
149	1505	48° 22.12'	017° 27.68'	151	0936	48° 19.10'	017° 24.46'
149	1535	48° 21.71'	017° 27.78'	151	1006	48° 18.84'	017° 25.36'
149	1605	48° 21.52'	017° 27.41'	151	1036	48° 18.49'	017° 26.10'

151	1106	48° 18,31'	017° 27.02'	153	0435	48° 16.97'	016° 52.39'
151	1136	48° 18.06'	017° 27.48'	153	0535	48° 06.11,	016° 51.96'
151	1206	48° 17.84'	017° 27.81'	153	0605	48° 05.62'	016° 51.66'
151	1237	48° 17.82'	017° 28.06'	153	0635	48° 05.55'	016° 51.55'
151	1307	48° 19.54'	017° 21.72'	153	0705	48° 05.42'	016° 51.49'
151	1337	48° 21 35'	017° 14.95'	153	0735	48° 04.93'	016° 51.19'
151	1407	48° 22.05'	017° 10.00'	153	0805	48° 04.57'	016° 50 97'
151	1507	48° 21.73'	017° 09.99,	153	0835	48° 03.98'	016° 50.78,
151	1537	48° 21 84'	017° 10.25'	153	0905	48° 03.54'	016° 50 71'
151	1607	48° 21.88'	017° 10.42'	153	0935	48° 03.05'	016° 50 66'
151	2135	48° 20.03'	017° 06.79'	153	1005	48° 02.49'	016° 50.58'
151	2205	48° 19.71'	017° 06.50'	153	1035	48° 01.94'	016° 50.47'
151	2235	48° 19.46'	017° 06.31'	153	1105	48° 01.38'	016° 50.33'
151	2305	48° 19.28'	017° 05.93'	153	1206	48° 00.29'	016° 50.38'
152	0035	48° 18.56'	017°•05.50'	153	1236	47° 59.79'	016° 50.32'
152	0105	48° 18.34'	017° 05.47'	153	1306	47° 59.44'	016° 50.43'
152	0135	48° 18.15'	017° 05.59'	153	1336	47° 59.13'	016° 50.75'
152	0235	48° 18.01'	017° 03.61'	153	1406	47° 58.87'	016° 51.15'
152	0335	48° 18.96'	017° 04.76'	153	1506	47° 58.71'	016° 51.37'
152	0405	48° 19.13'	017° 05.29'	153	1536	47° 58.59'	016° 51.50'
152	0435	48° 18 87'	017° 05.33'	153	1606	47° 58.49'	016° 51 56'
152	0535	48° 18 20'	017° 04 30'	153	2106	47° 56.07'	016° 49 83'
152	0605	48° 18 12'	017° 04.07'	153	2206	47° 55.26'	016° 49 18'
152	0635	48° 17.98'	017° 04.24'	153	2236	47° 54.90'	016° 48.95'
152	0705	48° 17.90'	017° 04.49'	153	2306	47° 54.40'	016° 48.61'
152	0735	48° 18.07'	017° 04.47'	154	0029	47° 53.37'	016° 48.42'
152	0805	48° 17 99'	017° 04.47'	154	0059	47° 53.31'	016° 47.86'
152	0835	48° 17 79'	017° 04.49'	154	0129	47° 53.00'	016° 47.34
152	0905	48° 17 60'	017° 04 36'	154	0229	47° 55.73'	016° 44.26'
152	0935	48° 17.51'	017° 04.23'	154	0329	47° 54.79'	016° 44.55'
152	1005	48° 17,32'	017° 04.20'	154	0359	47° 54.67'	016° 44.88'
152	1035	48° 17 09'	017° 04 10'	154	0429	47° 54.62'	016° 45.10'
152	1105	48° 17 10'	017° 03.97'	154	0530	47° 54.68'	016° 46.05'
152	1135	48° 16.82'	017° 03.72'	154	0600	47° 54.70'	016° 46.05'
152	1205	48° 16.06'	017° 03.64'	154	0630	47° 54.62'	016° 46.03'
152	1305	48° 15 71'	017° 03.89'	154	0700	47° 54.34'	016° 46.00'
152	1335	48° 15.35'	017° 03 60'	154	0730	47° 54 25'	016° 45.96'
152	1405	48° 14.96'	017° 03.20'	154	0800	47° 54.03'	016° 45.84'
152	1505	48° 14,37'	017° 01.51'	154	0830	47° 54.00'	016° 45.76'
152	1535	48° 14.07'	017° 00.82'	154	0900	47° 53.50'	016° 45.52'
152	1605	48° 13.79'	017° 00.22'	154	0930	47° 52.87'	016° 45.37'
152	2105	48° 08.98'	016° 58.67'	154	1000	47° 52.56'	016° 45.76'
152	2135	48° 08.79'	016° 58.81'	154	1030	47° 52.35'	016° 45.71'
152	2205	48° 08.48'	016° 58.98'	154	1100	47° 52.13'	016° 45.63'
152	2235	48° 08.84'	016° 58.86'	154	1130	47° 51.81'	016° 45.52'
152	2305	48° 07.68'	016° 58.84'	154	1200	47° 51.54'	016° 45.50'
153	0035	48° 06.56'	016° 58.12'	154	1230	47° 51.27'	016° 45.48'
153	0105	48° 06.45'	016° 57.90'	154	1300	47° 51.00'	016° 45.51'
153	0135	48° 06.39'	016° 57.10'	154	1330	47° 50.49'	016° 45.17'
153	0235	48° 08.42'	016° 53.67'	154	1400	47° 50.17'	016° 45.48'
153	0335	48° 07 74'	016° 53.09'	154	1500	47° 49 90'	016° 45.59'
153	0405	48° 07.36'	016° 52.72'	154	1530	47° 49.68'	016° 45.73'

154	1600	47° 49.48'	016° 46.09'	156	0901	47° 37.87'	016° 26.50'
154	2100	47° 45.52'	016° 48.46'	156	0931	47° 37.84'	016° 26.42'
154	2130	47° 45.45'	016° 48.92'	156	1001	47° 37.83'	016° 26 34'
154	2200	47° 44 87'	016° 49.54'	156	1031	47° 37.84'	016° 26 34'
154	2230	47° 44.71'	016° 50.36'	156	1101	47° 38.16'	016° 26.54'
154	2300	47° 44.55'	016° 51.01'	156	1131	47° 38.15'	016° 26.31'
155	0030	47° 44.46'	016° 53.15'	156	1201	47° 38.03'	016° 26 10'
155	0100	47° 44.59'	016° 53.80'	156	1231	47° 37.85'	016° 25.84'
155	0130	47° 44.57'	016° 54.09'	156	1301	47° 37.81'	016° 25.57'
155	0230	47° 45.16'	016° 39.18'	156	1331	47° 37.83'	016° 25.25'
155	0330	47° 45.31'	016° 36.78'	156	1531	47° 37.45'	016° 24.28'
155	0400	47° 45.06'	016° 36.35'	156	2101	47° 35.33'	016° 21.18'
155	0430	47° 44.79'	016° 36.04'	156	2231	47° 34.78'	016° 21.17'
155	0500	47° 44.53'	016° 35.84'	157	0031	47° 33.45'	016° 19.82'
155	0530	47° 44.20'	016° 35.49'	157	0101	47° 33.32'	016° 19.53'
155	0600	47° 43.76'	016° 35.31'	157	0301	47° 33.73'	016° 11.43'
155	0630	47° 43.31'	016° 35.17'	157	0331	47° 33.23'	016° 11.54'
155	0)00	47° 42.84'	016° 35.10'	157	0401	47° 32.71'	016° 11.38'
155	0730	47° 42.46'	016° 35.03'	157	0431	47° 32.30'	016° 11.30'
155	0800	47° 42.11'	016° 35.01'	157	0531	47° 32.03'	016° 10.92'
155	0830	47° 41.72'	016° 34.96'	157	0601	47° 31.67'	016° 10.82'
155	0900	47° 41.48'	016° 35.08'	157	0631	47° 31.39'	016° 10.83'
155	0930	47° 41.26'	016° 35.12'	157	0701	47° 31.05'	016° 10.69'
155	1000	47° 41.13'	016° 35.26'	157	0731	47° 30.59'	016° 10.50'
155	1030	47° 41.09'	016° 35.37'	157	0801	47° 30.22'	016° 10.45'
155	1100	47° 40.91'	016° 35.53'	157	0831	47° 30.03'	016° 10.49'
155	1130	47° 49.62'	016° 35.55'	157	0901	47° 29.87'	016° 10.61'
155	1200	47° 40.27'	016° 35.50'	157	0931	47° 29.59'	016° 10.51'
155	1230	47° 39.87'	016° 35.46'	157	1001	47° 29.50'	016° 10.40'
155	1300	47° 39.46'	016° 35.46'	157	1031	47° 29.76'	016° 10.48'
155	1330	47° 39.04'	016° 35.01'	157	1101	47° 32.64'	016° 10.31'
155	1400	47° 38.88'	016° 34.67'	157	1131	47° 32.67'	016° 10.52'
155	1500	47° 38.78'	016° 33.50'	157	1201	47° 32.42'	016° 10.42'
155	1530	47° 38.58'	016° 33.61'	157	1231	47° 31.07'	016° 08.74'
155	1600	47° 38.48'	016° 33.46'	157	1301	47° 30.21'	016° 05.98'
155	2100	47° 37.80'	016° 30.88'	157	1401	47° 30.29'	016° 05.25'
155	2200	47° 37.74'	016° 29.98'	157	1501	47° 30.14'	016° 04.62'
155	2230	47° 37.74'	016° 29.49'	157	2101	47° 33.80'	016° 20.11'
156	0030	47° 36.03'	016° 28.17'	157	2201	47° 38.12'	016° 33.04'
156	0100	47° 35.62'	016° 27.94'	157	2231	47° 40.31'	016° 39.30'
156	0130	47° 35.30'	016° 27.89'	158	0001	47° 46.84'	016° 58.11'
156	0301	47° 37.82'	016° 25.42'	158	0031	47° 48.86'	017° 04.49'
156	0331	47° 37.79'	016° 25.61'	158	0101	47° 50.76'	017° 10.79'
156	0401	47° 37.87'	016° 25.80'	158	0201	47° 54.58'	017° 23.85'
156	0431	47° 37.84'	016° 25.88'	158	0301	47° 57.83'	017° 32.27'
156	0501	47° 37.81'	016° 25.95'	158	0331	47° 59.35'	017° 44.13'
156	0531	47° 37.84'	016° 26.02'	158	0401	48° 01.18'	017° 50.70'
156	0601	47° 37.82'	016° 26.12'	158	0501	48° 05.00'	018° 03.59'
156	0631	47° 37.79'	016° 26.29'	158	0531	48° 06.98'	018° 09.88'
156	0701	47° 37.67'	016° 26.35'	158	0601	48° 08.38'	018° 16.13'
156	0731	47° 37.74'	016° 26.37'	158	0631	48° 08.97'	018° 19.16'
156	0801	47° 37.85'	016° 26.30'	158	0701	48° 07.16'	018° 18.71'
156	0831	47° 37.88'	016° 26.27'	158	0731	48° 08.79'	018° 16.74'

158	0807	48° 09.38'	018° 20.17'	160	0059	47° 19.68'	015° 46.46'
158	0837	48° 06.82'	018° 21.33'	160	0159	47° 19.02'	015° 45.83'
158	0907	48° 05.55'	018° 16.98'	160	0259	47° 18.37'	015° 45.47'
158	0958	48° 09.28'	018° 15.18'	160	0329	47° 18.45'	015° 45.61'
158	1028	48° 09.70'	018° 20.96'	160	0359	47° 18.48'	015° 45.57'
158	1058	48° 06.33'	018° 22.77'	160	0459	47° 12.99'	015° 38.72'
158	1128	48° 04.19'	018° 19.10'	160	0529	47° 10.34'	015° 34.65'
158	1158	48° 02.80'	018° 12.50'	160	0559	47° 10.16'	015° 34.54'
158	1228	47° 58.65'	018° 06.32'	160	0629	47° 10.05'	015° 34.57'
158	1258	47° 54.43'	018° 00.25'	160	0659	47° 09.92'	015° 34.69'
158	1329	47° 53.08'	017° 54.21'	160	0730	47° 09.82'	015° 34.70'
158	1359	47° 52.88'	017° 48.28'	160	0800	47° 09.94'	015° 34.68'
158	1459	47° 43.78'	017° 50.69'	160	0830	47° 10.05'	015° 34.71'
158	1529	47° 43.79'	017° 51.01'	160	0900	47° 10.05'	015° 34.84'
158	2059	47° 37.82'	017° 11.45'	160	0930	47° 10.04'	015° 34.90'
158	2159	47° 35.10'	016° 55.04'	160	1000	47° 10.07'	015° 34.66'
158	2229	47° 33.99'	016° 46.42'	160	1030	47° 10.04'	015° 34.55'
158	2359	47° 30.86'	016° 21.30'	160	1100	47° 10.21'	015° 34.65'
159	0029	47° 29.85'	016° 13.01'	160	1130	47° 10.28'	015° 34.39'
159	0059	47° 28.22'	016° 05.14'	160	1200	47° 10.13'	015° 34.45'
159	0159	47° 23.20'	015° 52.66'	160	1230	47° 09.95'	015° 34.43'
159	0259	47° 19.67'	015° 47.60'	160	1300	47° 09.73'	015° 34.46'
159	0329	47° 19.52'	015° 47.34'	160	1330	47° 09.56'	015° 34.49'
159	0359	47° 19.60'	015° 47.26'	160	1430	47° 09.46'	015° 33.87'
159	0459	47° 19.70'	015° 46.90'	160	1500	47° 09.44'	015° 33.63'
159	0529	47° 19.70'	015° 46.90'	160	1530	47° 09.34	015° 33.25'
159	0559	47° 19.67'	015° 46.90'	160	1600	47° 09.28'	015° 33.17'
159	0629	47° 19.65'	015° 47.05'	160	2030	47° 05.49'	015° 29.38'
159	0659	47° 19.51'	015° 47.25'	160	2100	47° 05.56'	015° 29.18'
159	0729	47° 19.43'	015° 47.34'	160	2130	47° 05.57'	015° 29.07'
159	0759	47° 19.38'	015° 47.42'	160	2200	47° 05.67'	015° 29.03'
159	0829	47° 19.35'	015° 47.53'	160	2230	47° 05.92'	015° 28.81'
159	0859	47° 19.30'	015° 47.48'	160	2359	47° 06.07'	015° 28.16'
159	0929	47° 19.31'	015° 47.26'	161	0029	47° 05.69'	015° 27.39'
159	0959	47° 19.35'	015° 47.11'	161	0059	47° 04.65'	015° 26.88'
159	1029	47° 19.33'	015° 46.92'	161	0159	47° 02.56'	015° 25.77'
159	1059	47° 19.38'	015° 46.77'	161	0259	47° 01.83'	015° 24.82'
159	1129	47° 19.45'	015° 46.63'	161	0329	47° 01.55'	015° 24.81'
159	1159	47° 19.31'	015° 46.39'	161	0359	47° 01.56'	015° 24.90'
159	1229	47° 19.12'	015° 46.58'	161	0500	47° 01.58'	015° 24.63'
159	1259	47° 19.21'	015° 46.46'	161	0530	47° 01.40'	015° 24.79'
159	1329	47° 19.27'	015° 46.36'	161	0600	47° 01.37'	015° 24.85'
159	1429	47° 19.27'	015° 46.17'	161	0630	47° 01.19'	015° 24.90'
159	1459	47° 19.24'	015° 46.23'	161	0700	47° 01.15'	015° 24.89'
159	1529	47° 19.32'	015° 46.21'	161	0730	47° 01.15'	015° 24.80'
159	1559	47° 19.46'	015° 46.26'	161	0800	47° 01.27'	015° 24.90'
159	2029	47° 19.76'	015° 46.11'	161	0830	47° 01.32'	015° 25.01'
159	2059	47° 19.84'	015° 46.00'	161	0900	47° 01.36'	015° 25.16'
159	2129	47° 19.93'	015° 45.93'	161	0930	47° 01.41'	015° 25.12'
159	2159	47° 19.96'	015° 45.92'	161	1000	47° 01.54'	015° 25.29'
159	2229	47° 19.97'	015° 45.92'	161	1030	47° 01.66'	015° 25.32'
159	2359	47° 19.65'	015° 46.41'	161	1100	47° 01.60'	015° 25.44'
160	0029	47° 19.52'	015° 46.38'	161	1130	47° 01.62'	015° 25.60'

161	1200	47° 01.53'	015° 25.86'	163	0905	46° 33.20'	015° 41.47'
161	1230	47° 01.56'	015° 25.96'	163	0935	46° 32.98'	015° 41.98'
161	1300	47° 01.57'	015° 26.18'	163	1005	46° 32.74'	015° 42.64'
161	1330	47° 01.65'	015° 26 34'	163	1035	46° 32.48'	015° 43.08'
161	1430	47° 01.91'	015° 26.11'	163	1105	46° 32.31'	015° 43.64'
161	1500	47° 02.16'	015° 26.00'	163	1135	46° 32.18'	015° 44.31'
161	1530	47° 02.26'	015° 25.98'	163	1205	46° 31.98'	015° 44.98'
161	1600	47° 02.30'	015° 25.92'	163	1235	46° 31.79'	015° 45.67'
161	2034	47° 03.52'	015° 24.21'	163	1305	46° 31.63'	015° 46.31'
161	2134	46° 56.53'	015° 23.75'	163	1335	46° 31.63'	015° 46.97'
161	2204	46° 55.85'	015° 24.21'	163	1435	46° 31.43'	015° 47.56'
162	0004	46° 55.39'	015° 24.74'	163	1505	46° 31.25'	015° 47.69'
162	0034	46° 55.28'	015° 24.87'	163	1535	46° 30.90'	015° 47.74'
162	0104	46° 55 32'	015° 24.97'	163	2035	46° 28.75'	015° 50.89'
162	0304	46° 54.49'	015° 25.69'	163	2135	46° 28.20'	015° 51.87'
162	0334	46° 54.58'	015° 25.76'	163	2205	46° 27.91'	015° 52.30'
162	0404	46° 54.68'	015° 25.68'	164	0005	46° 26.61'	015° 53.87'
162	0504	46° 54.97'	015° 25.89'	164	0035	46° 26.34'	015° 54.42'
162	0534	46° 55.18'	015° 25.80'	164	0135	46° 25.29'	015° 55 58'
162	0604	46° 55.29'	015° 25 82'	164	0235	46° 18.58,	016° 00.00'
162	0634	46° 55.28'	015° 25.80'	164	0305	46° 18.22'	016° 00.78'
162	0704	46° 55.38'	015° 25.79'	164	0335	46° 18.01'	016° 01.44'
162	0734	46° 55.52'	015° 25.75'	164	0435	46° 17.83'	016° 02.35'
162	0804	46° 55.58,	015° 25.56'	164	0505	46° 17.90,	016° 02.69'
162	0834	46° 55.54'	015° 25.17'	164	0535	46° 17.94'	016° 03.19'
162	0904	46° 55.41'	015° 24.78'	164	0605	46° 18.10'	016° 03.80'
162	0934	46° 55.35'	015° 24.56'	164	0635	46° 17.99'	016° 04.32'
162	1004	46° 55.22'	015° 24.32'	164	0705	46° 17.78'	016° 04.77'
162	1034	46° 55.04'	015° 23.95'	164	0735	46° 17.66'	016° 05.13'
162	1104	46° 54.59'	015° 23.62'	164	0805	46° 17.51'	016° 05.34'
162	1134	46° 54.59'	015° 23.56'	164	0835	46° 17.36'	016° 05.76'
162	1204	46° 54.31'	015° 23.42'	164	0905	46° 17.23'	016° 06.27'
162	1234	46° 54.17'	015° 23.29'	164	0935	46° 17.14'	016° 06.43'
162	1335	46° 53.99'	015° 23.71'	164	1005	46° 17.07'	016° 06.63'
162	1435	46° 54.14'	015° 24.11'	164	1035	46° 16.91'	016° 07.15'
162	1505	46° 54.24'	015° 24.28'	164	1105	46° 16.77'	016° 07.39'
162	1535	46° 54.31'	015° 24.84'	164	1135	46° 16.49'	016° 07.89'
162	2035	46° 55.77'	015° 27.46'	164	1205	46° 16.31'	016° 08.41'
162	2135	46° 55.97'	015° 26.96'	164	1236	46° 16.11'	016° 08.51'
163	0005	46° 56.26'	015° 24.66'	164	1306	46° 15.94'	016° 08.83'
163	0035	46° 56.21'	015° 23.77'	164	1336	46° 15.68'	016° 09.19'
163	0305	46° 43.46'	015° 25.82'	164	1436	46° 14.84'	016° 09.99'
163	0335	46° 39.63'	015° 26.37'	164	1506	46° 14.05'	016° 10.64'
163	0405	46° 38.86'	015° 27.00'	164	1536	46° 13.38'	016° 11.87'
163	0435	46° 37.14'	015° 33.52'	164	2025	46° 09.08,	016° 18.01'
163	0505	46° 35.82'	015° 37.17'	164	2125	46° 09.08'	016° 18.54'
163	0535	46° 35.33'	015° 37.59'	164	2155	46° 08.92'	016° 18.99'
163	0605	46° 34.98'	015° 38.12'	164	2255	46° 08.66'	016° 20.06'
163	0635	46° 34.72'	015° 38.56'	164	2355	46° 08.50'	016° 20.96'
163	0705	46° 34.48'	015° 39.04'	165	0025	46° 08.46'	016° 21.38'
163	0735	46° 34.13'	015° 39.66'	165	0125	46° 08.70'	016° 22.20'
163	0805	46° 33.73'	015° 40.35'	165	0255	46° 07.79'	016° 23.92'
163	0835	46° 33.52'	015° 40.95'	165	0325	46° 07.71'	016° 24.17'

165	0355	46° 07.83'	016° 24.34'	166	1551	46° 07.80'	016° 35.95'
165	0426	46° 07.63'	016° 24.49'	166	1951	46° 08.15'	016° 37.51'
165	0456	46° 07.49'	016° 24 59'	166	2021	46° 07.96'	016° 37.72'
165	0526	46° 07.12'	016° 24 81'	166	2121	46° 07.62'	016° 38.15'
165	0556	46° 06.96'	016° 24.90'	166	2151	46° 07.49'	016° 38.41'
165	0626	46° 06.88'	016° 25.14'	166	2351	46° 08.13'	016° 37.02'
165	0656	46° 06.78'	016° 25.33'	167	0021	46° 10.59'	016° 30.46'
165	0726	46° 06.74'	016° 25.43'	167	0121	46° 15.54'	016° 16.73'
165	0756	46° 06.46'	016° 25.46'	167	0251	46° 23.21'	015° 56.21'
165	0826	46° 06.17'	016° 25.74'	167	0321	46° 25.80'	015° 49.05'
165	0856	46° 05.92'	016° 26.08'	167	0421	46° 31.33'	015° 34.49'
165	0926	46° 05.65'	016° 26.37'	167	0451	46° 34.18'	015° 27.02'
165	0956	46° 05.52'	016° 26.63'	167	0521	46° 37.12'	015° 19.45'
165	1026	46° 05.39'	016° 26.95'	167	0551	46° 40.08'	015° 11.95'
165	1056	46° 05.37'	016° 27.22'	167	0621	46° 43.03'	015° 04.40'
165	1126	46° 05.17'	016° 27.55'	167	0651	46° 46.46'	014° 56.70'
165	1156	46° 05.11'	016° 27.76'	167	0721	46° 49.23'	014° 49.12'
165	1226	46° 05.03'	016° 27.79'	167	0751	46° 52.48'	014° 41.58'
165	1256	46° 04.89'	016° 27.80'	167	0821	46° 55.58'	014° 34.68'
165	1326	46° 04.95'	016° 27.78'	167	0851	46° 56.74'	014° 32.72'
165	1426	46° 04.57'	016° 27.92'	167	0921	46° 58.45'	014° 29.27'
165	1456	46° 04 35'	016° 28.00'	167	0951	47° 00.20'	014° 25.80'
165	2021	46° 02.95'	016° 27.50'	167	1021	47° 01.43'	014° 23.35'
165	2121	46° 02.42'	016° 27.63'	167	1052	47° 02 64'	014° 21.22'
165	2151	46° 02.19'	016° 27.90'	167	1122	47° 03.93'	014° 18.99'
165	2251	46° 01.86'	016° 28.51'	167	1152	47° 05.26'	014° 16.51'
165	2351	46° 01.45'	016° 28.12'	167	1452	47° 24.56'	013° 25.38'
166	0021	46° 01.19'	016° 28.28'	167	1522	47° 24.56'	013° 25.38'
166	0251	46° 00.92'	016° 43.58'	167	1552	47° 27.49'	013° 17.32'
166	0321	46° 00.70'	016° 50.12'	167	1952	47° 53.71'	012° 15.90'
166	0351	46° 01.29'	016° 45.36'	167	2022	47° 56.76'	012° 08.18'
166	0421	46° 02.48'	016° 37.72'	167	2122	48° 03.18'	011° 53.03'
166	0451	46° 06.35'	016° 32.68'	167	2152	48° 06.59'	011° 45.49'
166	0521	46° 08.58'	016° 26.85'	167	2352	48° 19.34'	011° 15.13'
166	0551	46° 08.45'	016° 26.94'	167	2359	48° 20.12'	011° 13.21'
166	0621	46° 08.39'	016° 27.57'	168	0029	48° 23.23'	011° 05.98'
166	0651	46° 08.25'	016° 28.00'	168	0220	48° 37.08'	010° 38.14'
166	0721	46° 08.19'	016° 28.50'	168	0259	48° 40.62'	010° 31.20'
166	0751	46° 07.45'	016° 29.81'	168	0329	48° 44.14'	010° 24.25'
166	0821	46° 07.37'	016° 30.63'	168	0430	48° 51.34'	010° 10.12'
166	0851	46° 07.47'	016° 31.33'	168	0500	48° 54.93'	010° 03.13'
166	0921	46° 07.63'	016° 31.97'	168	0530	48° 58.61'	009° 56.00'
166	0951	46° 07.12'	016° 31.16'	168	0600	48° 02.47'	009° 48.84'
166	1021	46° 07.10'	016° 31.63'	168	0630	49° 06.44'	009° 41.60'
166	1051	46° 07.08'	016° 31.94'	168	0700	49° 10.83'	009° 34.38'
166	1121	46° 07.09'	016° 32.41'	168	0730	49° 13.79'	009° 26.40'
166	1151	46° 07.21'	016° 32.85'	168	0800	49° 17.26'	009° 18.13'
166	1221	46° 07.02'	016° 33.08'	168	0830	49° 20.84'	009° 09.87'
166	1251	46° 06.92'	016° 33.62'	168	0900	49° 24.39'	009° 01.51'
166	1321	46° 07.24'	016° 33.94'	168	0930	49° 27.87'	008° 52.95'
166	1421	46° 07.47'	016° 34.31'	168	1000	49° 31.30'	008° 44.38'
166	1451	46° 07.69'	016° 35.46'	168	1030	49° 33.16'	008° 39.63'
166	1521	46° 07.76'	016° 35.85'	168	1100	49° 36.34'	008° 30.59'

Day	Time (A)	Latitude (N)	Longitude (W)
168	1130	49° 37.45'	008° 25.35'
168	1200	49° 39.02'	008° 21.73'
168	1230	49° 41.12'	008° 15.26'
168	1300	49° 49.43'	008° 06.67'
168	1400	49° 49.21'	007° 49.99'
168	1430	49° 52.59'	007° 42.45'
168	1500	49° 55.40'	007° 34.31'
168	1530	49° 58.33'	007° 26.26'
168	1600	50° 01.38'	007° 18.38'
168	1930	50° 23.76'	006° 25.76'
168	2000	50° 27.12'	006° 18.78'
168	2030	50° 30.05'	006° 11.33'
168	2100	50° 32.82'	006° 03.56'
168	2300	50° 50.11'	005° 26.14'
169	0000	50° 53.07'	005° 17.27'
169	0030	50° 56.11'	005° 08.47'
169	0230	51° 08.30'	004° 35.25'
169	0300	51° 10.14'	004° 26.71'
169	0430	51° 15.01'	004° 07.20'
169	0500	51° 16.14'	004° 00.70'
169	0530	51° 16.97'	003° 53.64'
169	0600	51° 18.37'	003° 45.93'
169	0630	51° 19.01'	003° 38.17'
169	0700	51° 19.46'	003° 29.87'
169	0730	51° 20.52'	003° 21.33'
169	0800	51° 21.39'	003° 15.73'

7.2 Station Log

The following is a log of all "over-the-side" scientific operations; further details may be obtained in reports of appropriate scientific activities presented in Section 5.

Station No	Day	Time Start	Time Finish	Deployment	Comments
2705/1	147	1645	2206	SAPS cast #2	250, 350, 450, 600, 800 in
2705/2	147	1930	2106	Zooplankton nets	1) Gel net 100m 2) Gel net 30m x5 3) Apstein-20 35m
2705/3	147	2335	0120	Zooplankton nets 2) WP2-200 100m 3) WP2-200 100m 4) WP2-500 100m 5) WP2-500 100m	1) Apstein-55 100m
2805/1	148	0416	0545	GoFlo cast	2, 5, 10, 15, 20, 25, 30, 35, 40 & 75m
2805/2	148	0545	0600	GoFlo cast	25m for microzooplankton
2805/3	148	0700		Production rig	Deployed
2805/4	148	0720		CTD-300	profile aborted
2805/5	148	0800		CTD-300	standard cast
2805/6	148	0945	1000	CTD-100	Bedo cast
2805/7	148	1015	1410	SAPS cast #1	10, 30, 50, 100, 150m x2
2805/7	148	1105	1220	GoFlo cast	30m
2805/8	148	1315	1545	Zooplankton nets	Apstein-55 100m Apstein-20 100m Apstein App 200m WP2-200 150m WP2-200 100m x2 Big Gel net 200 100m Big Gel net 200 30m
2805/9	148	1800	1859	CTD-300	Pigments & isotopes
2805/10	148	1900	1913	GoFlo cast	10m
2805/11	148	1915	2240	CTD-750	Radionucleides
2905/1	149	0001	0204	Zooplankton nets	Apstein-20 100m WP2-100 100m WP2-200 50m WP2-200 100m WP2-200 100m WP2-500 100m WP2-200 100m
2905/2	149	0200		Production rig	Recovered
2905/3	149	0400	0510	GoFlo cast	2, 5, 10, 15, 20, 30, 35, 40, 70m
2905/4	149	0600		Production rig	Deployed
2905/5	149	0625	0645	CTD-300	Standard cast
2905/6	149	0805	0840	CTD-300 "Level 1"	Shallow cast
2905/7	149	1100	1145	CTD	Profile + 3 bottles @ 30m
2905/8	149	1235	1333	Zooplankton nets	Apstein-55 100m WP2-200 100m WP2-200 100m WP2-l00 50m Gel net 200m

					Gel net 50m
2905/9	149	1351		Zooplankton net	Apstein-20 35m formicrozoopl'n
2905/10	149	1505	2251	CTD-4000 " Level 1"	Deep cast
2905/11	149	1540	1641	SAP	10m for Wyman/Chadd
2905/12	149	1705		CTD cast	Aborted due to winch problems
2905/13	149	2230	2240	GoFlo cast	Pigments @ 10, 30m
					Zooplankton @ 10m
3005/1	150	0005	0025	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					WP2-500 100m
3005/2	150	0400	0510	Production rig	Recovery
3005/3	150	0615	0645	GoFlo cast	Primary Production water
3005/4	150	0645	0705	GoFlo cast	Microzooplankton grazing
3005/5	150	0730		Production rig	Deployment
3005/6	150	0740	0817	CTD-300	Standard cast
3005/7	150	0815	0840	Zooplankton nets	Apstein-100 100m
					Apstein-100 50m
3005/8	150	1000	1102	SAPS #A	50m
3005/9	150	1100	1113	GoFlo	Wyman 30m for RNA
3005/10	150	1205	1314	Zooplankton nets	Apstein-55 100m
					WP2-200 50m
					WP2-200 100m
					WP2-200 50m
					WP2-200 100m
					WP2-200 100m
					Gel Net 100m
					Gel Net 30m
3005/11	150	1400	1600	SAPS #6	50+50, 100+100, 125+125w
3005/12	150	1605	1627	Zooplankton nets	WP2-200 100m
					WP2-200 100m
3005/13	150	1805	1825	CTD-100	Standard cast
3005/14	150	2005	2026	Zooplankton nets	WP2-200 100m
					WP2-200 100m
3105/1	151	0010	0043	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					WP2-500 100m
3105/2	151	0200		Production rig	Recovered
3105/3	151	0310	0333	Zooplankton nets	WP2-200 100m
					WP2-200 100m
3105/4	151	0640	0655	CTD-100	2, 10, 30, 40, 60, 100m for Head
3105/5	151	0727	0751	CTD-300	Standard cast
3105/6	151	0830	0933	CTD-750	Brand radioisotopes
3105/7	151	1205	1220	CTD-100	Wyman DNA 30mx3, 25mx3
3105/8	151	1230	1321	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					Apstein-55 100m
					WP2-200 50m x4
					Gel net 50m x2
3105/9	151	1323	1330	Zooplankton net	Apstein-20 35m for microzoopl'n
3105/10	151	1610	2033	SAPS #8	750+750, 800+800, 1000+1000m
3105/11	151	1850	1859	CTD-30	10, 30m for Bedo
0106/1	152	0010	0116	Zooplankton nets	Apstein-20 100m
					WP2-100 100m

					WP2-200 50m
					WP2-200 100m
					WP2-200 100m
					WP2-500 100m
0106/2	152	0430	0610	GoFlo cast	2, 5, 10, 15, 20, 25, 30, 35, 40, 75m
0106/3	152	0610	0621	GoFlo cast	10m x2 for microzooplankton
0106/4	152	0700		Production rig	Deployed
0106/5	152	0720	0749	CTD-300	Standard cast
0106/6	152	1130	1140	GoFlo cast	DNA @ 30m for Wyman
0106/7	152	1205v	1300	Zooplankton nets	Apstein-55 100m
					WP2-200 100m
					WP2-200 100m
					WP2-200 100m
					WP2-200 50m x3
					Gel net 100m
					Gel net 50m
0106/8	152	1315	1515	SAPS #5	25+25, 10+10, 75, 100m
0106/9	152	1820	1830	CTD-60	60x2, 40x2, 35x2, 30x2, 25, 15, 10, 5
0106/10	152	1900	1844	GoFlo cast	10, 30m for Bedo
0206/1	153	0001	0025	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					WP2-200 50m
0206/2	153	0300		Production rig	Recover
0206/3	153	0335	0353	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					WP2-200 50m
0206/4	153	0410	0510	GoFlo cast	2, 5, 10, 15, 20, 25, 30, 35, 40, 75m
0206/5	153	0555		Production rig	Deployed
0206/6	153	0615	0641	CTD-300	Standard depths
0206/7	153	0810	0825	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					WP2-200 50m
0206/8	153	0900	0932	CTD-300 "Levell"	Shallow cast
0206/9	153	1145	1153	GoFlo cast	DNA 20m for Wyman
0206/10	153	1200	1230	Zooplankton nets	Apstein-55 100m
					WP2-200 100m
					WP2-200 100m
					WP2-200 50m
0206/11	153	1236	1742	CTD-4000 "Levell"	Deep cast
0206/12	153	1745	1810	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					WP2-200 50m
0206/13	153	1810	1815	Zooplankton net	Apstein-20 35m for microzoopl'n
0206/14	153	1915	1916	CTD-60	pigments & zooplankton
0206/15	153	2005	2020	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					WP2-200 50m
0206/16	153	2110	2222	SAPS -B	10, 15, 16m
0206/17	153	2120	2136	Zooplankton nets	WP2-200 x2
0306/1	154	0005	0051	Zooplankton nets	WP2-200
0306/2	154	0230		Production rig	Recovered
0306/3	154	0410	0500	GoFlo cast	2, 5, 10, 15, 20, 25, 30, 35, 40m
0306/4	154	0500	0511	GoFlo cast	10m for microzooplankton
0306/5	154	0540		Production rig	Deployed

0306/6	154	0605	0636	CTD-300	Standard depths
0306/7	154	0700	0717	CTD-100	2, 10, 20, 30, 60, 100m x2
0306/8	154	0800	0848	CTD-750	Raclionucleides
0306/9	154	1130	1150	CTD-100	DNA @ 24, 13m x2 for Wyman
0306/10	154	1200	1319	Zooplankton nets	Apstein-55 100m
					WP2-200 50m
					WP2-200 100m
					WP2-200 200m
					WP2-200 100m
					WP2-200 50m x4
					WP2-200 15m x2
0306/11	154	1335	1829	SAPS #7	600, 500x2, 350x2, 150m
0306/12	154	1800	1914	CTD	Aborted - bottle failure
0306/13	154	1900	1943	GoFlo	Zooplankton
0306/14	154	2100	2100	GoFlo	10, 30m for pigments
0406/1	155	0010	0113	Zooplankton nets	WP2-200 100m
					WP2-200 100m
					WP2-200 50m
					WP2-500 50m x2
0406/2	155	0230		Production rig	Recovered
0406/4	155	0400	0458	GoFlo cast	2, 5, 10, 15, 20, 25, 30, 35, 40, 75m
0406/5	155	0630	0705	CTD-300	Standard depths
0406/6	155	1145	1200	Zooplankton nets	Apstein-55 100m
					WP2-200 100m
					WP2-200 100m
					WP2-200 100m
					WP2-200 100m
					WP2-200 50m x4
					Gel net 100-200m
0406/6A	155	1320	1330	Zooplankton net	Apstein-20 35m for microzoopl'n
0406/7	155	1340	2315	SAPS #4	4500, 4000, 3500, 3010, 3000m
0406/8	155	1615	1616	GoFlo cast	DNA @ 25m x3 for Wyman
0406/9	155	1810	1814	GoFlo	Pigments @ 10, 30m
0406/10	155	1920	1926	GoFlo	Zooplankton
0506/1	156	0015	0100	Zooplankton nets	WP2-200 100m x2
					WP2-200 50m x2
0506/2	156	0215		Production rig	Recover
0506/3	156	0330	0400	Zooplankton nets	WP2-200 100m x2
					WP2-200 50m x2
0506/4	156	0400	0535	GoFlo cast	2, 5, 10, 15, 20, 25, 30, 40m
0506/4A	156	0545	0550	GoFlo cast	25m x2 for microzoopl'n
0506/5	156	0550		Production rig	Deployed
0506/6	156	0745	0807	Zooplankton nets	VP2-200 100m x2
					WP2-200 50m x2
0506/7	156	0815	0830	GoFlo cast	10, 30m for pigments
0506/8	156	0930	0940	GoFlo cast	10, 30m for Wyman
0506/9	156	1019	1040	CTD-300 "Level 1"	Shallow cast
0506/10	156	1200	1247	Zooplankton nets	Apstein-55 100m.
					WP2-200 100m x2
					WP2-200 100m x2
					WP2-200 50m x2
0506/11	156	1253	1945	CTD-4000 "Level 1"	Deep cast
0506/12	156	2000	2015	GoFlo cast	30m x2 - Morales; 25m -Wyman
0506/13	156	2015	2038	Zooplankton nets	WF2-200100m x2

					WP2-200 50m x2
0506/14	156	2030	2053	GoFlo cast	10, 30m for pigments
0506/15	156	2100	2212	SAPS #C	50, 60m trial
0606/1	157	0005	0054	Zooplankton nets	WP2-200 100m x4
					WP2-200 50m x2
0606/2	157	0222		Production rig	Recover
0606/3	157	0247		Steam to buoy 3917	
0606/4	157	0400	0534	GoFlo cast	Standard depths
0606/5	157	0600		Production rig	Deploy
0606/6	157	0705	0741	CTD-300	Standard depths
0606/7	157	0825	0844	CTD-l00	2, 10, 20, 30, 60, l00m x2
0606/8	157	0900	1008	CTD-750	Radionucleides
0606/9	157	1210	1227	CTD-100	DNA @ 38mx3 - Wyman, 10m - Gough
0606/10	157	1215	1250	Zooplankton nets	WP2-200 50m x3
0606/11	157	1250	1314	CTD-100	
0606/12	157	1410	1440	Zooplankton nets	Apstein-55 100m
					WP2-200 50m
					WP2-200 100m x2
0606/13	157	1440	1450	Zooplankton net	Apstein-20 35m for microzoopl'n
0606/14	157	1830	1857	CTD-100	Aborted
0606/15	157		1925	1924	GoFlo 15m
0606/16	157	2000	2001	CTD-l00	2, 5, 10, 20, 30, 50, 75, 100m
0606/17	157	2015	2040	Zooplankton nets	WP2-200 100m x3
0606/18	157	2040	2045	GoFlo	30m
0606	157	2100		Leave station	
0706/1	158	1930		Sediment trap	Recovered!!
0806/1	159	0400	0530	GoFlo cast	Standard depths
0806/2	159	0530	0544	GoFlo cast	25m x2 for microzooplank'n
0806/3	159	0615		Production rig	Deployed
0806/4	159	0640	0702	CTD-300	Standard depths
0806/5	159	0830	0851	Zooplankton nets	WP2-200 100m x2
					WP2-200 50m
0806/6	159	1205	1224	CTD-100	5, 15, 25, 30, 35, 40x2, 60m2
0806/6A	159	1222	1225	CTD-100	DNA @ 40m x3
0806/7	159	1225	1307	Zooplankton nets	Apstein-55
					WP2-200 l00m x3
					WP2-200 50m
0806/8	159	1320	1956	SAPS #3	1000, 2000m
0806/9	159	1530	1553	Zooplankton nets	WP2-200 l00m
					WP2-200 50m
0806/10	159	1800	181	GoFlo cast	l0, 30, 1000, 1250, l500, 2000m
0806/11	159	1815	182	GoFlo cast	20m
0806/12	159	1930	200	Zooplankton nets	WP2-200 l00m x2
					WP2-200 SCm
0906/1	160	0010	0042	Zooplankton nets	WP2-200 100m x3
					WP2-200 50m x2
0906/2	160	0340	0433	Zooplankton nets	WP2-200 l00m x3
					WP2-200 50m x3
0906/3	160	0430		GoFlo cast	30m for Wyman
0906/4	160	0445		Production rig	Recover
0906/5	160	0630	0637	GoFlo cast	25m x2 for microzooplankton
0906/6	160	0700	0717	CTD-100	Standard depths

0906/7	160	0800	0832	CTD-300 "Level 1"	Shallow cast
0906/8	160	1000	1033	GoFlo cast	25m x2 for Chadd
0906/9	160	1030	1159	SAPS test	30, 40, 50m
0906/10	160	1200	1215	GoFlo cast	DNA @ 30m for Wyman
0906/11	160	1230	1345	Zooplankton nets	Apstein-55 various 0 WP2-200 various x6
0906/12	160	1350	1618	CTD-2000 Level 1"	Deep cast to 2000m
0906/13	160	1700	1728	GoFlo cast	100m - pigments
0906/14	160	2000	2110	GoFlo cast	Standard depths for production
0906/15	160	2100		Production rig	Deploy
1006/1	161	0001	0052	Zooplankton nets	Apstein-20 100m WP2-200 100m x3 WP2-200 25m WP2-200 50m WP2-200 200m
1006/1	161	0620	0653	CTD-300	Standard depths
1006/1	161	0715	0845	SAPS TS1	50, 100m
1006/1	161	1130	1240	Zooplankton nets	Gel net 50m x2 Apstein-55 100m WP2-200 100m x2 WP2-200 50m
1006/5	161	1240	1252	CTD-100	DNA @ in for Wyman
1006/6	161	1310	1455	SAPS T52	50, 100m
1006/7	161	1330	1342	Zooplankton net	Apstein-20 35m for microzoopl'n
1006/8	161	1345	1355	Zooplankton nets	WP2-200 50m x4
1006/9	161	1830	1841	CTD- 100	Pigments & isotopes
1006/10	161	1850	1851	GoFlo cast	10m for Bedo & Morales
1006/11	161	1910	2058	SAPS TS3	50, 100m
1006/12	161	2100		Production rig	Recover
1106/1	162	0005	0035	Zooplankton nets	WP2-200 100m x2 WP2-200 50m x2
1106/1A	162	0110	0250	SAPS TS4	50, 100m
1106/2	162	0320	0404	Zooplankton nets	WP2-200 100m x3 WP2-200 50m x5 WP2-200 30m
1106/3	162	0400	0520	GoFlo cast	Standard depths for production
1106/3A	162	0520	0536	GoFlo cast	10m x2 for microzoopl'n
1106/4	162	0620		Production rig	Deployed
1106/5	162	0640	0705	CTD-300	Standard depths
1106/6	162	0720	0850	SAPS TS5	50, 100m
1106/7	162	0800	0825	Zooplankton nets	WP2-200 100m x2 WP2-200 50m x2
1106/8	162	1000	1011	GoFlo cast	Ultraclean bottle @ 10w for Chadd
1106/9	162	1200	1250	Zooplankton nets	WP2-200 100m x3 WP2-200 50m x3
1106/10	162	1315	1453	SAPS TS6	50, 100m
1106/11	162	1415	1424	GoFlo cast	DNA @30w for Wyman
1106/12	162	1600	1641	Zooplankton nets	Apstein-55 100m WP2-200 100m x2 WP2-200 50m WP2-200 200m
1106/13	162	1845	1856	GoFlo cast	10, 30m for pigments
1106/14	162	1910	2048	SAPS TS7	50, 100m
1106/15	162	2000	2005	GoFlo cast	zooplankton

1106/16	162	2010	2030	Zooplankton nets	WP2-200 100m x2 WP2-200 50w x2
1106/16A	162	2030	2035	Zooplankton net	Apstein-20 35m for microzoopl'n
1106/17	162	2330	0014	Zooplankton nets	WP2-200 100m x4 WP2-200 50m x4
1206/1	163	0030	0209	SAPS TS8	50, 100m
1206/2	163	0230		Production rig	Recover
1206/3	163	0600	0700	GoFlo cast	Standard depths for production
1206/4	163	0700	0710	GoFlo cast	ultraclean for Chadd
1206/5	163	0710	0723	Zooplankton net	WP2-200 for Wyman
1206/6	163	0740		Production rig	Deployed
1206/7	163	0840	0903	CTD-100	2, 10, 20, 30, 60, 100m -zooplankton level 1 shallow missing
1206/8	163	1210	1306	Zooplankton nets	Apstein-55 100m WP2-200 25m WP2-200 50m x3 WP2-200 100m x2 WP2-200 200m
1206/9	163	1330	1630	CTD-2000 "Level 1"	Deep cast
1206/10	163	2005	2016	GoFlo cast	zooplankton & pigments
1206/11	163	2015	2027	Zooplankton nets	WP2-200 30m x2
1306/1	164	0005	0104	Zooplankton nets	Apstein-55 100m WP2-100 100m WP2-200 25m WP2-200 50m WP2-200 100m x4
1306/2	164	0200		Productivity rig	Recover
1306/3	164	0400	0510	GoFlo cast	Standard depths forproductivity
1306/4	164	0510	0541	GoFlo cast	10m x2 for microzooplankton
1306/5	164	0540		Productivity rig	Deployed
1306/6	164	0740	0802	CTD-300	Standard depths
1306/7	164	0815	1409	SAPS #10	200, 300, 400, 600, 800, 1000m
1306/8	164	1000	1100	Zooplankton nets	Apstein-55 x4 WP2-200 30m x2
1306/9	164	1100	1107	GoFlo cast	DNA @ 20m for Wyman
1306/10	164	1200	1230	Zooplankton nets	Apstein-55 100m WP2-200 l00m x2
1306/10A	164	1230	1235	Zooplankton net	Apstein-20 35m for microzoopl'n
1306/11	164	1410	1505	CTD-750	Isotopes
1306/12	164	1800	1825	CTD-100	Pigments & isotopes
1306/13	164	1830	1835	GoFlo cast	10m for zooplankton
1406/1	165	0005	0050	Zooplankton nets	WP2-200 30m x2 WP2-200 50m x2 WP2-200 100m x3
1406/2	165	0230		Production rig	Recovered
1406/3	165	0335	0403	Zooplankton nets	WP2-200 30m x2 WP2-200 l00m x3
1406/4	165	0400	0540	GoFlo cast	Standard depths for production
1406/5	165	0615		Production rig	Deployed
1406/6	165	0710	0700	CTD-300	Standard depths
1406/7	165	0800	0825	Zooplankton nets	WP2-200 30m x2 WP2-200 l00m x2
1406/8	165	0900	1128	SAPS #9	l0, 30, 50, 75, 100, 50m

1406/9	165	1200	1222	CTD-100	DNA for Wyman
1406/10	165	1220	1318	Zooplankton nets	Apstein-55 100m
				WP2-200 30m x2	
				WP2-200 50m x2	
				WP2-200 100m x3	
1406/11	165	1400	1610	SAPS EXTRA!	
1406/12	165	1605	1634	Zooplankton nets	WP2-200 30m x2
					WP2-200 100m x2
1406/12A	165	1700		Zooplankton nets	Apstein-20 35m for microzoopl'n
1406/13	165	1800	1823	CTD-100	Stable isotopes & pigments
1406/14	165	2000	2026	Zooplankton nets	WP2-200 30m x2
					WP2-200 100m x2
1506/1	166	0010	0046	Zooplankton nets	WP2-200 30m x2
					WP2-200 100m x4
1506/2	166	0230		Production rig	Recovered
1506/3	166	0640	0714	CTD-300	Standard depths
1506/4	166	0725	0735	GoFlo cast	Standard depths for production
1506/5	166	0735	0741	GoFlo cast	25m x2 for microzoopl'n
1506/6	166	0830	0858	Zooplankton nets	WP2-200 5014 x6
1506/7	166	0915	0957	SAPS #"Extra"	30m
1506/8	166	0930	0935	GoFlo cast	30m for 'sappers'
1506/9	166	1150	1152	GoFlo cast	DNA @ 30m for Wyman
1506/10	166	1210	1226	Zooplankton nets	Apstein-55 100m
				WP2-200 25m	
				WP2-200 30m	
				WP2-200 50m x3	
				WP2-200 100m x3	
				WP2-200 200m	
1506/11	166	1300		Zooplankton net	Apstein-20 @ 35m for microzoopl'n
1506/12	166	1335		Buoy 3917	Recovered
1506/13	166	1342	1402	GoFlo cast	for zooplankton
1506/14	166	1630	1717	CTD-100	for biopolymers
1506/15	166	1810	1842	CTD-300 "Level 1"	Shallow cast
1506/16	166	1930	2251	CTD-3500	Radionucleides
1506/18	166	2315	0020	Zooplankton nets	Apstein-20 100m
				WP2-200 25m	
				WP2-200 50n x3	
				WP2-200 100m x5	
1606	167	0021		Sail for Barry	

7.3 CTD bottle firing parameters

285/C04

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
07:48:33	302.9	10.936	35.504	5.623	-0.371	4.441	2.896	2.979
07:57:56	150.0	11.351	35.571	5.593	-0.374	4.436	2.905	2.996
08:00:29	100.2	11.453	35.580	5.608	-0.374	4.429	2.791	2.993
08:03:10	75.5	11.579	35.600	5.578	-0.374	4.421	1.387	2.991
08:04:40	60.1	11.719	35.617	5.502	-0.374	4.421	1.216	2.988
08:06:14	49.0	11.847	35.634	5.440	-0.374	4.414	1.116	2.981
08:07:50	38.1	11.977	35.644	5.553	-0.374	4.382	0.894	2.954
08:09:12	29.2	12.055	35.627	5.565	-0.073	4.336	0.686	1.382
08:10:27	18.9	12.944	35.643	5.614	1.487	4.155	0.420	1.006
08:11:37	9.3	14.287	35.519	5.599	2.571	3.616	0.042	0.664
08:14:52	5.8	14.625	35.636	5.950	1.912	3.479	-0.161	0.476

285/C04A

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
08:37:12	301.0	10.883	35.491	5.728	-0.369	4.485	2.874	2.964
08:40:27	200.3	11.279	35.563	5.628	-0.369	4.480	2.886	2.976
08:42:31	151.1	11.348	35.570	5.546	-0.371	4.478	2.893	2.981
08:44:48	99.5	11.538	35.592	5.561	-0.371	4.463	2.883	2.986
08:46:31	75.4	11.711	35.616	5.562	-0.371	4.463	2.817	2.988
08:48:01	59.9	11.887	35.637	5.425	-0.371	4.448	1.299	2.983
08:49:39	50.7	11.970	35.622	5.449	-0.269	4.404	1.113	2.979
08:50:56	40.3	12.403	35.637	5.649	1.001	4.294	0.959	2.961
08:52:24	31.0	13.913	35.635	5.752	2.297	3.914	0.701	1.399
08:54:08	20.3	14.484	35.635	5.821	2.310	3.608	0.344	0.903
08:55:22	10.5	14.690	35.637	5.938	2.153	3.516	-0.049	0.559
08:56:54	5.7	14.706	35.637	6.028	1.572	3.506	-0.261	0.327

285/C04

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
09:51:23	100.2	11.492	35.589	5.799	-0.361	4.470	2.756	2.932
09:53:37	60.5	11.704	35.612	5.683	-0.364	4.453	1.033	2.922
09:55:45	30.9	12.678	35.625	5.615	1.406	4.233	0.598	1.201
09:57:07	20.4	13.960	35.672	5.802	2.554	3.909	0.298	0.840
09:58:24	10.5	14.645	35.635	5.954	2.725	3.538	-0.054	0.496
10:00:12	5.9	14.761	35.638	6.021	2.302	3.491	-0.291	0.330

285/C09

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
18:45:18	60.4	11.743	35.625	5.518	-0.366	4.478	1.289	2.983
18:47:05	40.3	11.982	35.641	5.803	1.226	4.321	0.857	2.942
18:48:47	34.7	12.340	35.633	5.851	1.890	4.175	0.725	1.594
18:50:00	29.5	13.516	35.628	6.144	2.170	4.065	0.586	1.221
18:51:22	24.9	14.187	35.614	6.262	2.322	3.940	0.427	0.974
18:52:41	15.4	14.673	35.634	6.163	2.554	3.389	0.088	0.620
18:53:56	10.7	14.849	35.640	6.196	2.300	3.181	-0.107	0.449
18:55:35	6.9	14.958	35.633	6.144	1.814	3.362	-0.295	0.295

285/C10

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
21:14:02	3500.6	2.609	34.919	5.190	-0.393	4.497	0.000	0.000
21:28:20	3000.8	2.861	34.942	5.288	-0.396	4.497	0.000	0.000
21:39:53	2499.6	3.288	34.947	5.476	-0.396	4.497	0.000	0.000

21:50:19	2000.0	3.585	34.909	5.584	-0.396	4.497	0.000	0.000
22:00:32	1499.6	4.347	34.974	5.276	-0.393	4.497	0.000	0.000
22:10:27	1000.5	7.409	35.269	4.285	-0.393	4.495	0.000	0.000

295/C05

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06:25:27	297.0	21.876	26.928	3.998	-0.359	4.954	2.925	2.866
06:29:57	201.3	21.987	26.998	4.046	-0.361	4.495	2.959	2.896
06:32:12	4507.0	6.872	27.263	11.920	-0.364	4.749	2.971	2.905
06:34:17	309.6	11.195	35.461	5.765	-0.366	4,487	3.057	2.910
06:35:38	81.5	11.342	35.568	5.753	-0.366	4.451	2.981	2.915
06:36:46	373.7	11.371	35.431	6.062	-0.366	4.438	2.981	2.917
06:37:40	177.7	11.420	35.513	5.983	-0.288	4.407	2.979	2.917
06:38:34	46.7	11.587	35.555	5.921	0.962	4.272	2.964	2.917
06:39:38	36.8	12.459	52.028	5.295	1.909	4.114	2.815	2.915
06:40:34	30.4	15.856	33.735	5.713	2.585	3.774	1.006	2.891
06:41:28	17.4	14.582	35.579	6.085	2.512	3.450	0.613	1.287
06:43:02	20.4	15.046	35.628	6.002	2.432	3.420	0.015	0.637

295/C06

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
08:12:49	300.9	10.823	35.504	5.589	-0.361	4.500	2.910	2.888
08:16:34	200.4	11.096	35.542	5.528	-0.366	4.495	2.944	2.905
08:19:05	150.3	11.194	35.550	5.566	-0.366	4.487	2.959	2.913
08:21:26	100.5	11.327	35.565	5.484	-0.369	4.475	2.959	2.915
08:23:13	74.6	11.486	35.588	5.563	-0.369	4.463	2.905	2.915
08:24:49	60.1	11.576	35.597	5.548	-0.369	4.458	1.333	2.913
08:26:21	49.3	11.850	35.640	5.534	-0.371	4.463	1.104	2.905
08:27:41	40.1	12.047	35.644	5.600	1.257	4.299	0.906	2.878
08:29:14	29.8	13.697	35.577	5.694	2.310	3.940	0.637	1.306
08:30:23	20.0	14.386	35.607	5.917	2:422	3.831	0:317	0.867
08:31:34	10.1	14.896	35.638	5.885	2.280	3.391	-0.164	0.332
08:33:56	6.1	14.851	35.630	6.013	2.000	3.474	-0.637	0.137

295/C07

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
11.11.07	29.6	13.207	35.646	5.288	1.836	4.104	0.481	0.969

295/C10

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
16:16:13	4181.8	2.512	34.899	5.107	-0.393	4.490	0.000	0.000
16:35:58	2999.5	2.861	34.942	5.232	-0.396	4.504	0.000	0.000
16:50:33	2500.0	3.296	34.946	5.437	-0.396	4.504	0.000	0.000
17:01:47	2000.4	3.583	34.913	5.573	-0.396	4.502	0.000	0.000

295/C11

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
21:36:36	1500.9	4.180	34.942	5.282	-0.393	4.502	0.000	0.000
21:47:09	1200.5	5.425	35.059	4.777	-0.393	4.500	0.000	0.000
21:51:59	1000.2	7.629	35.331	4.245	-0.391	4.500	0.000	0.000
21:57:39	800.0	8.621	35.248	4.247	-0.391	4.497	0.000	0.000
22:00:36	700.3	9.069	35.237	4.703	-0.388	4.497	0.000	0.000
22:04:05	599.6	10.119	35.400	5.141	-0.388	4.497	0.000	0.000
22:07:44	500.2	10.483	35.460	5.308	-0.386	4.495	0.000	0.000
22:11:11	400.1	10.817	35.502	5.537	-0.383	4.492	0.000	0.000

305/C05

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
07:48:50	301.0	10.596	35.659	5.516	-0.359	4.504	2.954	2.891
07:52:16	196.8	10.870	35.507	5.698	-0.364	4.504	2.971	2.905
07:55:55	149.3	10.962	35.522	5.639	-0.366	4.500	2.986	2.917
07:57:57	98.5	11.101	35.539	5.771	-0.366	4.475	2.988	2.920
07:59:18	74.4	11.178	35.547	5.877	-0.366	4.460	2.986	2.922
08:00:59	59.6	11.294	35.549	5.833	-0.322	4.404	2.981	2.925
08:02:09	49.4	11.428	35.559	5.974	0.312	4.338	2.957	2.922
08:03:25	39.6	12.159	35.544	5.926	1.536	4.185	2.898	2.922
08:04:32	30,1	13.536	35.548	6.009	2.473	3.918	1.047	2.900
08:08:40	20.7	14.581	35.552	6.161	1.831	3.557	0.557	1.135
08:10:52	10.3	15.260	35.578	5.960	1.428	3.484	0.149	0.750
08:12:45	6.7	15.264	35.577	6.081	1.340	3.396	0.061	0.750

305/C05

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
18:10:15	100.9	11.111	35.543	6.022	-0.339	4.487	2.698	2.742
18:12:11	59.4	11.263	35.559	5.798	-0.342	4.465	0.830	2.593
18:13:42	39.7	11.360	35.565	6.286	-0.239	4.436	0.623	1.223
18:15:26	35.7	11.376	35.565	6.004	-0.281	4.424	0.437	1.018
18:16:47	29.4	11.420	35.566	6.161	0.068	4.355	0.327	0.916
18:18:04	25.4	11.461	35.567	6.080	1.003	4.331	0.232	0.842
18:19:38	15.6	14.773	35.544	5.890	2.551	3.528	-0.005	0.505
18:20:37	10.3	14.853	35.566	6.162	2.339	3.513	-0.203	0.300
18:22:11	7.0	14.868	35.565	6.102	1.990	3.506	-0.447	0.066

315/C04

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06:42:59	97.3	11.311	35.565	5.861	-0.371	4.446	2.952	2.881
06:45:09	58.8	11.721	35.590	5.768	0.789	4.304	2.944	2.891
06:47:23	30.1	14.960	35.653	5.681	2.380	3.748	1.016	2.861
06:49:11	20.0	14.963	35.652	5.787	1.951	3.748	0.679	1.382
06:50:57	10.4	14.961	35.651	5.841	1.741	3.745	0.315	0.891
06:52:50	6,4	14.959	35.651	5.856	1.675	3.745	0.134	0.696

315/CO5

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
07:27:26	299.9	10.918	35.516	5.769	-0.366	4.497	2.954	2.891
07:30:34	199.4	11.149	35.552	5.742	-0.369	4.485	2.966	2.900
07:32:55	150.8	11.197	35.556	5.678	-0.369	4.485	2.974	2.908
07:35:14	98.5	11.328	35.565	5.628	-0.369	4.446	2.976	2.913
07:37:19	74.8	11.420	35.567	5.634	-0.010	4.385	2.964	2.915
07:38:58	59.9	11.793	35.553	5.584	0.813	4.329	2.776	2.913
07:40:26	49.7	12.154	35.605	5.544	0.942	4.297	1.216	2.905
07:41:41	40.1	12.823	35.635	5.440	1.841	4.145	0.928	2.871
07:43:00	30.0	14.896	35.653	5.436	2.273	3.782	0.645	1.248
07:44:19	20.0	14.958	35.649	5.591	1.833	3.750	0.305	0.813
07:45:40	10.5	14.955	35.649	5.687	1.504	3.745	-0.046	0.505
07:47:15	7.1	14.954	35.650	5.780	1.272	3.740	-0.183	0.305

315/C06

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
09:04:05	749.6	8.742	35.252	4.742	-0.369	4.504	0.000	0.000
09:10:36	500.2	10.223	35.388	5.343	-0.371	4.504	0.000	0.000
09:15:18	350.1	10.796	35.471	5.482	-0.374	4.502	0.000	0.000

09:22:29	100.5	11.563	35.596	5.542	-0.374	4.465	0.000	0.000
09:25:08	50.4	11.903	35.616	5.686	-0.334	4.429	0.000	0.000
09:27:00	25.3	14.699	35.609	5.651	2.263	3.806	0.000	0.000

016/C05

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
07:25:35	301.6	10.817	35.512	5.917	-0.374	4.500	2.942	2.886
07:29:00	201.2	10.925	35.521	5.831	-0.374	4.490	2.961	2.900
07:31:42	150.4	11.038	35.536	5.785	-0.374	4.487	2.969	2.910
07:34:16	100,9	11.139	35.541	5.701	-0.374	4.490	2.954	2.913
07:36:11	74.7	11.232	35.557	5.711	-0.374	4.485	2.888	2.915
07:37:46	60.1	11.273	35.560	5.706	-0.374	4.465	1.340	2.910
07:38:54	50.2	11.332	35.564	5.764	-0.376	4.443	1.204	2.905
07:40:07	39.2	11.383	35.561	5.812	-0.376	4.385	0.886	2.854
07:41:32	29.5	12.045	35.564	5.831	1.614	4.172	0.679	1.321
07:43:10	20.4	14.362	35.580	5.734	2.620	3.625	0.356	0.925
07:44:46	9.6	14.507	35.581	5.823	1.973	3.540	-0.127	0.354
07:46:06	5.8	14.502	35.581	5.962	1.531	3.538	-0,615	0.125

016/C09

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
18:18:03	60.2	11.304	35.563	5.394	-0.356	4.485	0.959	2.844
18:20:00	40.8	11.433	35.574	6.152	-0.356	4.465	0.693	1.416
18:21:44	35.8	11.446	35.576	6.063	-0.254	4.426	0.645	1.301
18:23:14	29.8	11.701	35.557	6.189	0.806	4.297	0.537	1.113
18:24:22	25.1	12.509	35.586	6.387	1.946	4.043	0.417	0.969
18:26:01	15.4	14.739	35.600	6.125	2.866	3.352	0.054	0.583
18:27:11	10.6	14.864	35.599	6.230	2.349	3.357	-0.161	0.405
18:28:31	6.9	14.861	35.596	6.138	2.095	3.354	-0.383	0.283

026/C06

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06:19:48	303.0	10.816	35.508	5.962	-0.369	4.500	2.947	2.878
06:23:20	200.9	10.982	35.529	5.853	-0.371	4.495	2.966	2.898
06:25:36	149.8	11.086	35.543	5.745	-0.371	4.492	2.976	2.905
06:27:39	100.2	11.211	35.553	5.754	-0.371	4.478	2.979	2.913
06:29:16	74.6	11.6						
07:15:07	6.2	14.941	35.597	5.743	1.997	3.623	-0.266	0.481

036/C08

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
08:18:02	749.5	9.222	35.324	4.820	-0.369	4.504	0.000	0.000
08:28:30	500.2	10.511	35.472	5.701	-0.374	4.500	0.000	0.000
08:33:13	349.5	10.769	35.504	5.639	-0.374	4.500	0.000	0.000
08:40:05	100.1	11.160	35.549	5.513	-0.376	4.485	0.000	0.000
08:42:21	49.4	11.352	35.572	5.619	-0.376	4.453	0.000	0.000
08:44:03	24.5	12.408	35.595	5.612	1.709	4.189	0.000	0.000

036/C12

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
18:53:24	60.3	11.321	35.566	5.854	-0.356	4.492	0.135	1.536
18:55:05	40.3	11.462	35.583	5.952	-0.359	4.485	0.564	1.089
18:56:17	34.8	11.632	35.606	6.194	-0.359	4.470	0.515	1.006
19:00:08	29.7	11.719	35.614	6.318	-0.251	4.424	0.605	1.155
19:01:46	24.8	12.316	35.608	5.877	1.289	4.243	0.457	0.886

046/C05

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06:36:41	300.9	10.824	35.510	5.930	-0.374	4.495	2.959	2.898
06:41:58	200.7	10.985	35.530	5.845	-0.374	4.492	2.979	2.913
06:44:12	149.8	11.073	35.540	5.818	-0.374	4.480	2.983	2.917
06:46:27	100.6	11.188	35.550	5.780	-0.374	4.482	2.979	2.920
06:48:19	75.4	11.280	35.561	5.728	-0.374	4.482	2.959	2.920
06:50:15	59.8	11.332	35.567	5.685	-0.374	4.485	2.910	2.920
06:55:02	50.1	11.505	35.588	5.674	-0.374	4.456	1.497	2.917
06:56:09	40.3	11.614	35.602	5.718	-0.317	4.399	1.221	2.910
06:57:12	31.0	12.951	35.607	5.686	2.122	4.075	0.969	2.888
06:58:31	21.2	15.125	35.606	5.682	2.034	3.728	0.652	1.323
06:59:49	10.4	15.207	35.609	5.776	1.379	3.706	0.237	0.781
07:01:10	6.9	15.206	35.609	5.839	1.060	3.706	0.056	0.662

056/C09

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
10:19:02	302.5	10.880	35.521	6.142	-0.361	4.500	2.896	2.834
10:22:43	199.7	10.955	35.526	5.773	-0.364	4.492	2.935	2.869
10:24:46	149.7	11.105	35.546	5.776	-0.364	4.492	2.944	2.883
10:26:55	100.2	11.194	35.559	5.848	-0.366	4.485	2.920	2.893
10:28:47	75.1	11.379	35.573	5.747	-0.366	4.463	1.243	2.891
10:30:28	59.7	11.456	35.586	5.767	-0.366	4.434	0.945	2.866
10:32:05	50.6	11.556	35.603	5.710	0.601	4.390	0.798	2.810
10:33:36	40.6	11.937	35.603	5.680	1.165	4.285	0.654	1.321
10:35:22	29.5	14.771	35.609	5.596	2.336	3.823	0.273	0.798
10:36:53	20.0	14.950	35.612	5.767	1.880	3.779	-0.056	0.471
10:38:24	9.8	14.954	35.612	5.915	0.796	3.779	-0.322	0.220
10:40:02	5.5	14.961	35.612	5.976	0.566	3.777	-0.654	0.059

056/C11

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
14:30:06	4497.5	2.547	34.899	5.221	-0.393	4.490	0.000	0.000
16:30:36	2999.4	2.856	34.942	5.191	-0.396	4.500	0.000	0.000
16:46:07	2499.5	3.236	34.951	5.386	-0.396	4.497	0.000	0.000
17:27:20	2000.7	3.578	34.913	5.586	-0.393	4.497	0.000	0.000
18:05:04	1499.1	4.475	34.991	5.279	-0.393	4.500	0.000	0.000
18:26:47	1200.5	6.119	35.175	4.716	-0.388	4.497	0.000	0.000
18:36:10	1000.2	7.929	35.362	4.254	-0.388	4.497	0.000	0.000
19:04:59	800.5	8.984	35.346	4.307	-0.381	4.495	0.000	0.000
19:10:26	699.7	9.512	35.336	4.785	-0.381	4.497	0.000	0.000

066/C06

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
07:11:57	300.9	10.794	35.503	5.784	-0.371	4.492	2.949	2.878
07:15:43	199.7	10.972	35.526	5.726	-0.371	4.487	2.969	2.898
07:18:23	150.5	11.040	35.526	5.707	-0.371	4.487	2.979	2.908
07:22:39	100.7	11.269	35.559	5.678	-0.374	4.482	2.986	2.917
07:25:47	74.1	11.362	35.571	5.660	-0.374	4.475	2.983	2.920
07:29:42	59.5	11.490	35.588	5.656	-0.374	4.456	2.969	2.920
07:31:24	50.1	11.667	35.599	5.590	-0.374	4.426	2.942	2.920
07:32:59	40.1	12.374	35.583	5.604	1.121	4.265	1.477	2.915
07:34:24	29.4	14.764	35.624	5.567	2.217	3.840	0.950	2.878
07:35:32	20.1	14.819	35.615	5.682	1.787	3.828	0.610	1.270
07:36:48	9.8	14.816	35.615	5.754	1.411	3.828	0.171	0.784
07:38:19	6.9	14.818	35.614	5.800	1.255	3.823	-0.010	0.642

066/C07

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
08:28:48	102.2	11.349	35.572	5.820	-0.361	4.473	2.915	2.869
08:31:29	60.0	11.689	35.606	5.653	-0.364	4.426	1.304	2.871
08:33:47	29.5	14.845	35.612	5.496	2.324	3.838	0.498	1.057
08:35:46	18.7	14.856	35.615	5.685	2.131	3.833	0.144	0.688
08:37:21	10.4	14.849	35.614	5.741	2.002	3.838	-0.186	0.398
08:38:56	6.3	14.854	35.614	5.785	1.799	3.828	-0.515	0.227

066/C08

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
09:41:10	750.4	9.491	35.347	4.841	-0.369	4.500	0.000	0.000
09:48:17	500.5	10.519	35.609	5.609	-0.371	4.500	0.000	0.000
09:52:24	350.6	10.798	35.503	5.619	-0.374	4.495	0.000	0.000
09:58:21	99.2	11.312	35.562	5.556	-0.374	4.473	0.000	0.000
10:00:29	50.7	11.900	35.555	5.487	0.166	4.353	0.000	0.000
10:02:59	25.6	14.892	35.615	5.538	2.039	3.828	0.000	0.000

066/C09

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
12:19:36	38.2	14.056	35.580	5.783	2.195	3.879	0.786	1.760
12:21:46	10.4	14.618	35.616	6.034	2.153	3.831	-0.154	0.457

066/C10

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
12:58:03	60.6	11.435	35.574	5.662	-0.361	4.470	1.030	2.847
12:59:45	39.9	12.982	35.668	5.864	1.423	4.177	0.769	2.708
13:01:10	35.1	14.439	35.616	5.928	2.207	3.877	0.625	1.311
13:02:55	31.3	14.600	35.616	5.852	2.288	3.838	0.530	1.118
13:04:34	25.2	14.616	35.614	5.863	2.202	3.828	0.347	0.898
13:06:16	15.3	14.625	35.612	5.830	2.214	3.826	0.022	0.608
13:07:31	9.8	14.633	35.617	5.873	2.124	3.823	-0.178	0.457
13:09:14	8.5	14.629	35.616	5.818	2.214	3.818	-0.188	0.471

066/C16

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
19:45:17	102.7	11.155	35.545	5.642	0.945	4.482	2.949	2.883
19:47:09	74.1	11.329	35.552	5.647	1.169	4.448	2.949	2.891
19:48:53	50.6	12.345	35.618	5.490	1.865	4.290	1.592	2.893
19:50:23	31.0	14.710	35.619	5.525	2.759	3.813	0.757	1.650
19:52:21	24.7	14.708	35.618	5.570	2.759	3.816	0.557	1.135
19:54:11	19.4	14.710	35.618	5.614	2.761	3.809	0.374	0.928
19:55:47	14.8	14.707	35.618	5.666	2.766	3.816	0.200	0.784
19:57:08	9.8	14.709	35.619	5.789	2.776	3.811	0.000	0.632
19:52:20	6.6	14.708	35.619	5.709	2.791	3.813	-0.273	0.525

086/C04

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06.41.47	301.4	10.822	35.499	5.611	0.564	4.502	2.969	2.900
06:45:29	199.5	11.150	35.543	5.629	0.715	4+485	2.981	2.913
06:47:46	151.0	11.300	35.564	5.571	0.691	4,487	2.986	2.917
06:50:06	99.6	11.461	35.576	5.585	0.876	4.448	2.986	2.920
06:51:46	75.4	11.727	35.613	5.592	0.820	4.456	2.979	2.920
06:53:08	59.8	11.855	35.619	5.629	1.152	4.395	2.954	2.920
06:54:10	49.7	12.312	35.619	5.715	1.475	4.363	2.900	2.917
06:55:19	40.4	13.875	35.619	5.642	2.075	4.175	1.182	2.098

06:56:27	30.5	14.433	35.607	5.621	2.329	4.084	0.869	2.854
06:57:37	20.3	14.787	35.616	5.617	2.590	3.899	0.559	1.143
06:58:35	9.5	14.952	35.610	5.700	2.654	3.840	0.151	0.698
06:59:58	7.2	14.949	35.613	5.610	2.605	3.848	0.015	0.591

086/C06

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
12:09:22	59.9	11.930	35.579	6.465	1.448	4.363	0.977	2.690
12:11:15	40.2	13.887	35.608	6.065	2.092	4.165	0.588	1.211
12:13:29	35.1	14.964	35.618	6.026	2.646	3.843	0.315	0.857
12:14:40	29.9	14.990	35.618	6.026	2.659	3.818	0.217	0.754
12:15:58	25.3	15.006	35.615	5.926	2.678	3.801	0.193	0.725
12:17:13	14.9	14.990	35.617	5.880	2.732	3.789	-0.337	0.227
12:18:41	6.6	15.076	35.614	5.969	1.995	3.796	-0.654	0.007

096/C06

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
07:06:06	100.2	11.894	35.643	5.924	0.601	4.495	2.910	2.859
07:08:28	60.3	12.149	35.671	5.817	0.874	4.470	2.793	2.866
07:10:28	30.2	12.854	35.688	5.795	1.501	4.387	0.857	2.803
07:11:58	20.1	14.972	35.627	5.750	2.656	3.882	0.559	1.177
07:13:19	10.2	15.276	35.650	5.848	2.559	3.884	0.222	0.815
07:15:01	7.3	15.259	35.650	5.802	2.546	3.884	0.081	0.703

096/C07

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
08:09:31	300.5	11.227	35.546	5.677	0.615	4.517	2.954	2.891
08:13:38	199.9	11.430	35.565	5.489	0.623	4.512	2.971	2.905
08:16:03	150.0	11.742	35.622	5.451	0.706	4.504	2.974	2.910
08:18:52	100.2	11.975	35.658	5.417	0.601	4.500	2.954	2.913
08:20:32	74.6	12.063	35.663	5.403	0.708	4.490	2,842	2.910
08:22:05	59.3	12.203	35.673	5.477	0.999	4.465	1.223	2.903
08:23:15	49.4	12.474	35.681	5.466	1.284	4.419	1.035	2.891
08:24:25	40.0	13.044	30.650	5.431	1.704	4.358	0.845	2.839
08:25:28	30.2	14.443	35.654	5.354	2.327	4.133	0.642	1.296
08:26:41	20.2	15.062	35.628	5.433	2.610	3.875	0,356	0.903
08:27:47	10.2	15.085	35.632	5.552	2.566	3.875	0.017	0.605
08:28:53	6.8	15.082	35.631	5.604	2.534	3.875	-0.156	0.503

096/C12

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
14:25:14	1998.0	3.590	34.909	5.844	0.410	4.524	0.000	2.500
14:51:40	1499.4	4.407	34.973	5.392	0.347	4.519	0.000	0.000
15:16:00	1200.1	6.782	35.290	4.660	0.422	4.519	0.000	0.000
15:22:56	999.3	7.908	35.340	4.347	0.574	4.517	0.000	0.000
15:43:58	800.4	9.079	35.319	4.357	0.493	4.514	0.000	0.000
15:48:24	699.8	9.805	35.367	4.839	0.588	4.512	0.000	0.000
15:52:58	599.1	10.255	35.422	5.181	0.640	4.512	0.000	0.000
15:56:18	498.0	10.236	35.381	5.066	0.562	4.514	0.000	0.000
15:59:09	400.2	10.778	35.461	5.216	0.579	4.514	0.000	0.000

106/CO2

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06:27:23	299.6	11.209	35.543	5.759	0.449	4.512	2.930	2.864
06:31:11	200.4	11.477	35.581	5.563	0.564	4.507	2.954	2.888
06:33:40	201.2	11.684	35.592	5.615	0.510	4.507	2.964	2.898

06:34:03	149.4	11.683	35.614	5.512	0.542	4.507	2.966	2.898
06:39:44	100.9	11.967	35.656	5.480	0.593	4.500	2.969	2.908
06:41:23	74.9	12.118	35.674	5.579	0.698	4.495	2.942	2.908
06:43:02	60.1	12.218	35.681	5.501	0.903	4.465	1.492	2.905
06:44:16	50.3	12.323	35.684	5.505	0.955	4.446	1.221	2.898
06:45:43	40.1	12.454	35.661	5.524	1.042	4.426	1.055	2.886
06:47:07	29.2	13.620	35.668	5.638	2.019	4.277	0.828	2.825
06:48:42	19.8	15.419	35.664	5.464	2.495	3.936	0.579	1.187
06:50:00	9.8	15.431	35.664	5.619	2.500	3.921	0.217	0.818
06:51:00	6.5	15.429	35.663	5.664	2.510	3.918	-0.063	0.735

106/C06

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
12:46:08	40.7	15.110	35.683	5.755	2.451	3.999	0.593	1.206

106/C09

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
18:29:05	65.3	12.228	35.685	5.682	0.847	4.480	1.028	2.849
18:30:27	54.3	12.311	35.691	5.656	1.299	4.443	0.901	2.825
18:31:54	44.6	12.640	35.685	5.716	1.958	4.346	0.759	1.787
18:33:24	39.4	13.433	35.671	5.622	2.244	4.285	0.645	1.287
18:34:47	30.6	15.284	35.688	5.474	2.625	4.006	0.452	0.986
18:35:59	24.1	15.290	35.685	5.616	2.683	3.984	0.278	0.811
18:37:07	14.8	15.306	35.680	5.772	2.727	3.943	0.000	0.544
18:37:57	9.8	15.310	35.679	5.892	2.637	3.936	-0.173	0.408
18:38:58	6.5	15.310	35.680	5.843	2.520	3.896	-0.303	0.354

116\C05

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06:45:43	300.3	11.220	35.552	5.728	0.652	4.514	2.939	2.878
06:48:28	200.0	11.413	35.569	5.612	0.630	4,512	2.954	2.891
06:50:33	149.2	11.686	35.611	5.477	0.735	4.504	2.964	2.900
06:52:32	99.7	11.985	35.651	5.516	0.693	4.502	2.966	2.905
06:54:07	74.1	12.231	35.688	5.486	0.779	4.485	2.961	2.908
06:55:18	59.5	12.355	35.689	5.444	0.996	4.463	2.939	2.908
06:56:31	49.1	12.596	35.707	5.439	1.453	4.404	2.861	2.905
06:57:29	39.7	12.932	35.660	5.539	1.851	4.329	1.201	2.898
06:58:40	28.7	15.295	35.676	5.394	2.524	3.989	0.889	2.844
06:59:47	19.4	15.300	35.666	5.559	2.522	3.967	0.596	1.230
07:01:02	10.4	15.310	35.665	5.663	2.532	3.970	0.293	0.908
07:02:19	7.3	15.305	35.666	5.603	2.507	3.967	0.137	0.791

126\C07

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
08:49:18	100.5	11.877	35.639	5.738	0.669	4.500	1.458	2.852
08:51:35	59.0	12.101	35.665	5.680	0.750	4.485	0.889	2.800
08:53:23	30.1	12.504	35.694	5.637	1.375	4.412	0.579	1.157
08:54:58	19.7	15.301	35.671	5.382	2.288	4.138	0.366	0.920
08:56:18	10.2	15.361	35.659	5.617	2.476	3.994	0.027	0.588
08:58:19	6.9	15.359	35.658	5.686	2.432	3.982	-0.166	0.442

126/C08

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
10:28:45	299.9	11.116	35.532	5.587	0.540	4.517	2.898	2.859
10:32:28	199.7	11.284	35.559	5.500	0.581	4.514	2.930	2.883
10:34:58	149.7	11.474	35.579	5.337	0.662	4.512	2.939	2.896

10:37:25	100.0	11.864	35.633	5.326	0.710	4.495	1.204	2.891
10:39:08	75.0	12.043	35.659	5.360	0.718	4.490	1.067	2.886
10:40:32	60.4	12.198	35.656	5.432	1.179	4.434	0.784	2.202
10:41:50	49.8	12.636	35.689	5.372	1.462	4.402	0.581	1.184
10:43:03	39.5	13.822	35.707	5.293	1.809	4.343	0.376	0.935
10:44:27	30.4	14.868	35.798	5.137	2.021	4.255	0.154	0.688
10:45:50	20.2	15.351	35.659	5.266	2.424	4.009	-0.037	0.540
10:47:08	9.9	15.412	35.659	5.482	1.777	3.999	-0.520	0.088

126/C10

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
14:02:58	2000.1	3.657	34.920	5.685	0.522	4.526	0.000	0.000
14:37:32	1500.1	4.675	35.016	5.277	0.376	4.521	0.000	0.000
14:54:58	1200.0	6.208	35.147	4.631	0.488	4.519	0.000	0.000
15:05:26	1000.3	8.200	35.326	4.270	0.557	4.517	0.000	0.000
15:20:02	800.0	9.524	35.337	4.417	0.503	4.517	0.000	0.000
15:33:41	700.0	10.333	35.436	5.186	0.537	4.514	0.000	0.000
15:41:08	599.5	10.480	35.450	5.256	0.508	4.514	0.000	0.000
15:43:52	499.3	10.704	35.480	5.320	0.571	4.514	0.000	0.000
15:46:21	399.4	10.926	35.515	5.329	0.544	4.514	0.000	0.000

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Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
07:41:07	300.6	11.172	35.552	5.840	0.571	4.512	2.942	2.874
07:44:38	200.0	11.207	35.540	5.440	0.554	4.514	2.954	2.891
07:46:37	149.8	11.403	35.567	5.408	0.640	4.507	2.942	2.898
07:48:51	99.7	11.704	35.615	5.469	0.510	4.497	1.245	2.893
07:50:43	74.9	11.833	35.635	5.317	0.642	4.497	0.972	2.869
07:52:06	59.4	11.930	35.650	5.462	0.620	4.485	0.811	2.788
07:53:15	49.2	11.999	35.657	5.488	0.728	4.485	0.696	1.409
07:54:40	38.9	12.079	35.660	5.444	0.977	4.448	0.557	1.143
07:55:49	29.9	12.293	35.654	5.506	1.567	4.373	0.417	0.967
07:56:59	20.0	14.580	35.656	5.344	2.109	4.224	0.190	0.728
07:58:27	10.1	15.351	35.652	5.372	2.500	4.023	-0.125	0.442
07:59:29	6.5	15.323	35.656	5.570	2.356	3.992	-0.332	0.325

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Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
14:22:07	750.6	10.233	35.414	5.464	0.562	4.529	0.000	0.002
14:33:51	499.9	10.792	35.494	5.555	0.544	4.521	0.000	0.000
14:43:20	349.5	11.070	35.524	5.565	0.532	4.521	0.000	0.000
14:54:49	100.8	11.784	35.627	5.418	0.483	4.514	0.000	0.000
14:57:12	49.6	12.076	35.665	5.471	0.686	4.487	0.000	0.000
15:00:15	24.0	14.252	35.676	5.241	2.390	4.260	0.000	0.000

136/C12

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
18:11:42	52.2	14.014	35.656	5.502	2.163	4.233	0.903	2.734
18:13:13	44.7	14.464	35.656	5.958	2.253	4.204	0.674	1.305
18:14:46	35.2	14.814	35.657	5.661	2.336	4.158	0.454	1.003
18:15:51	29.9	15.910	35.653	5.536	2.698	3.979	0.312	0.828
18:17:02	25.1	15.407	35.670	5.616	2.620	3.870	0.176	0.664
18:18:30	15.2	15.951	35.696	5.604	2.131	3.972	-0.132	0.381
18:19:47	10.2	16.203	35.717	5.479	1.702	4.023	-0.388	0.269
18:22:04	6.8	16.288	35.712	5.488	1.528	4.055	-0.618	0.117

146/C06

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06:36:54	300.2	11.140	35.544	5.696	0.442	4.514	2.944	2.883
06:40:39	199.7	11.309	35.567	5.642	0.640	4.509	2.964	2.900
06:43:48	149.6	11.355	35.561	5.341	0.608	4.512	2.974	2.908
06:46:23	99.6	11.601	35.597	5.492	0.674	4.500	2.971	2.913
06:48:08	74.8	11.878	35.641	5.470	0.615	4.495	2.954	2.913
06:49:46	60.1	11.975	35.656	5.473	0.806	4.485	2.908	2.913
06:51:10	50.1	12.127	35.659	5.508	1.147	4.424	1.372	2.908
06:52:17	40.5	13.697	35.715	5.282	1.985	4.285	1.064	2.893
06:53:20	30.6	15.001	35.783	5,381	2.385	4.097	0.806	2.778
06:54:33	20.4	15.439	35.671	5.442	2.441	3.994	0.535	1.094
06:55:54	11.0	15.868	35.679	5.429	2.285	3.982	0.215	0.789
06:57:19	6.6	15.897	35.679	5.581	2.166	3.994	-0.139	0.620

146/C09

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
12:13:12	25.5	14.130	35.658	5.422	2.192	4.241	0.237	0.762

146/C13

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
18:10:44	69.6	11.918	35.645	5.857	0.730	4.482	1.140	2.817
18:12:06	60.0	12.037	35.653	5.904	0.889	4.456	1.013	2.812
18:13:28	50.0	12.960	35.617	5.826	1.682	4.355	0.835	2.739
18:14:32	45.0	14.169	35.688	5.672	2.004	4.297	0.737	1.550
18:15:32	40.1	15.073	35.686	5.673	2.485	4.124	0.618	0.240
18:16:48	30.9	15.416	35.664	5.765	2.483	3.948	0.374	0.918
18:18:28	25.1	15.894	35.702	5.599	2.158	3.972	0.229	0.754
18:19:32	14.3	15.963	35.707	5.750	2.109	3.972	-0.051	0.503
18:20:27	9.6	15.994	35.703	5.758	1.997	3.967	-0.203	0.388
18:21:42	6.6	15.963	35.702	5.837	2.087	3.975	-0.332	0.332

156/C03

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
06:52:42	299.9	11.215	35.559	5.807	0.518	4.487	2.954	2.888
06:56:29	200.6	11.285	35.567	5.754	0.583	4.485	2.969	2.903
06:59:17	150.5	11.321	35.567	5.712	0.547	4.482	2.976	2.910
07:01:28	99.6	11.521	35.589	5.647	0.715	4.473	2.981	2.913
07:03:05	74.7	11.822	35.630	5.598	0.903	4.441	2.979	2.915
07:04:18	59.7	12.018	35.648	5.646	1.323	4.365	2.961	2.915
07:05:29	50.3	12.838	35.636	5.612	2.024	4.238	2.896	2.913
07:06:35	41.0	13.638	35.645	5.586	2.197	4.185	1.182	2.903
07:07:44	30.5	15.071	35.642	5.615	2.581	3.940	0.847	2.825
07:08:53	20.4	15.409	35.644	5.620	2.458	3.926	0.554	1.135
07:09:53	10.5	15.559	35.641	5.727	2.412	3.911	0.212	0.779
07:11:26	6.8	15.569	35.650	5.740	2.338	3.911	0.027	0.623

156/C15

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
18:20:53	300.3	11.196	35.555	5.641	0.571	4.504	2.957	2.900
18:24:46	198.7	11.270	35.567	5.650	0.544	4.504	2.969	2.910
18:28:06	149.5	11.304	35.568	5.597	0.610	4.497	2.974	2.917
18:30:00	101.2	11.530	35.575	5.488	0.625	4.490	2.913	2.915
18:31:28	74.5	11.753	35.622	5.416	0.854	4.468	1.265	2.910
18:32:53	60.5	11.869	35.637	5.436	1.067	4.438	1.011	2.891
18:33:55	50.1	11.995	35.655	5.490	1.335	4.392	0.796	2.771

18:35:07	39.8	13.189	35.683	5.419	2.063	4.221	0.591	1.150
18:36:03	30.3	14.974	35.648	5.486	2.512	4.045	0.479	0.964
18:37:01	20.7	15.655	35.681	5.543	2.324	3.962	0.220	0.642
18:38:22	10.7	16.070	35.668	5.600	1.948	3.975	-0.039	0.459
18:39:16	6.9	16.211	35.666	5.710	1.711	3.984	-0.168	0.398

156/C16

Time	Press	Temp	Salin	Oxygen	Fluor	Trans	DwIrr	UwIrr
20:47:13	3501.7	2.655	34.924	5.313	0.105	4.509	0.000	0.000
21:04:17	3000.6	2.943	34.945	5.324	0.171	4.509	0.000	0.000
21:26:09	2500.7	3.400	34.953	5.496	0.444	4.507	0.000	0.000
21:27:41	2501.9	3.396	34.954	5.580	0.422	4.507	0.000	0.000
21:47:34	2002.9	3.723	34.933	5.564	0.381	4.509	0.000	0.000
22:02:41	1498.2	4.556	34,986	5.239	0.615	4.507	0.000	0.000
22:17:14	1001.1	8.092	35.275	4.264	0.508	4.502	0.000	0.000

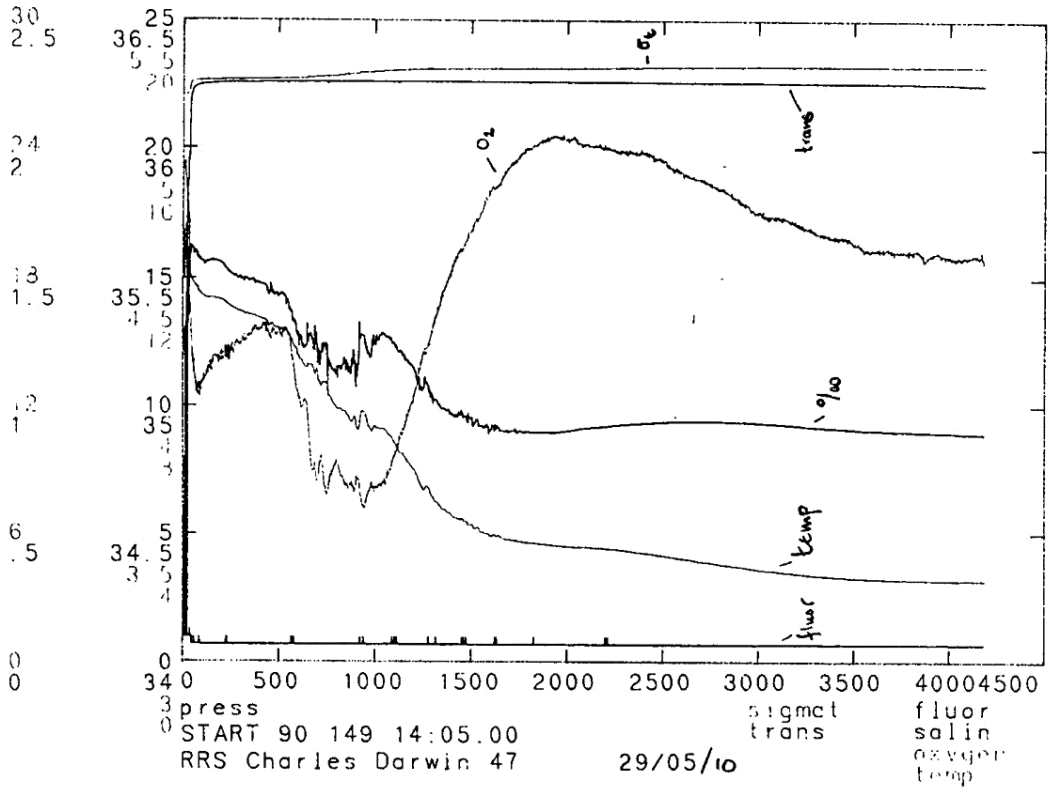
7.4 JGOFS/BOFS "Level 1" Activities

"Level l" State Variables	Responsibility
1) Positioning & Meteorology	RVS
2) CTD/O_2 probe	RVS
3) O_2 titrations	Duncan Purdie
4) Nutrients	Bob Head
5) Optics	RVS
6) CO_2	Emily Wood
7) POC/PON	Tim Brand
8) DOC	Tim Fileman
9) Pigments	Mark Gough
10a) Bacteria	Alan Pomroy
10b) Cyanobacteria	Mike Wyman
11) Mesozooplankton	Alain Bedo Carmen Morales Bob Head
12) Microzooplankton	Elaine Edwards
12a) Flow Cytometry	Glen Tarran

"Level 1" Rate Variables	
10a) Bacteria prod'n	Alan Pomroy
13) ^{14}C Primary Prod'n	Alan Pomroy
14) O_2 Primary Prod'n	Duncan Purdie
15) New Prod'n	Emily Wood
16) Mesozoopl Prod'n	Alain Bedo Carmen Morales Bob Head
17) Microzpl Prod'n	Elaine Edwards
18) Sediment Trapping	DISCOVERY

Sample Depths on Casts

Shallow: 2, 10, 20, 30, 40, 50, 75, 100, 125, 150, 200, 300 metres
Deep: 400, 600, 750, 900, 1000, 1500, 2250, 2750, 3250, 3750, 4250, 4500 metre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29/05/10
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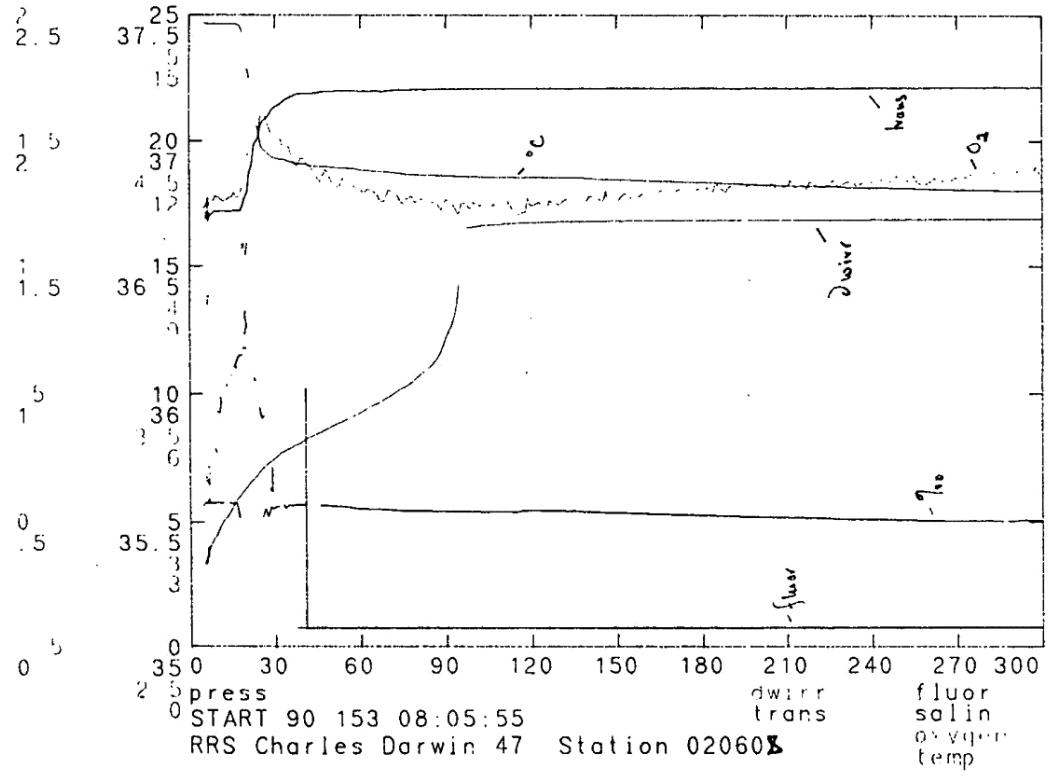
trans
fluor
salin
oxygen
temp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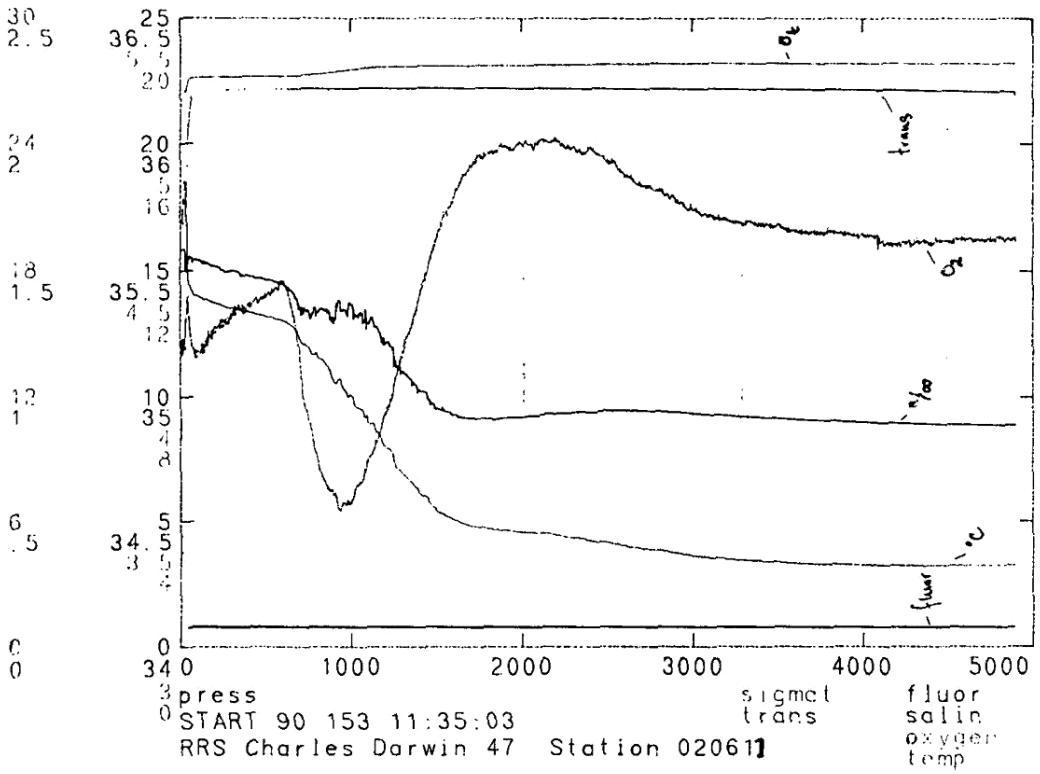
dwirr
trans
fluor
salin
oxygen
temp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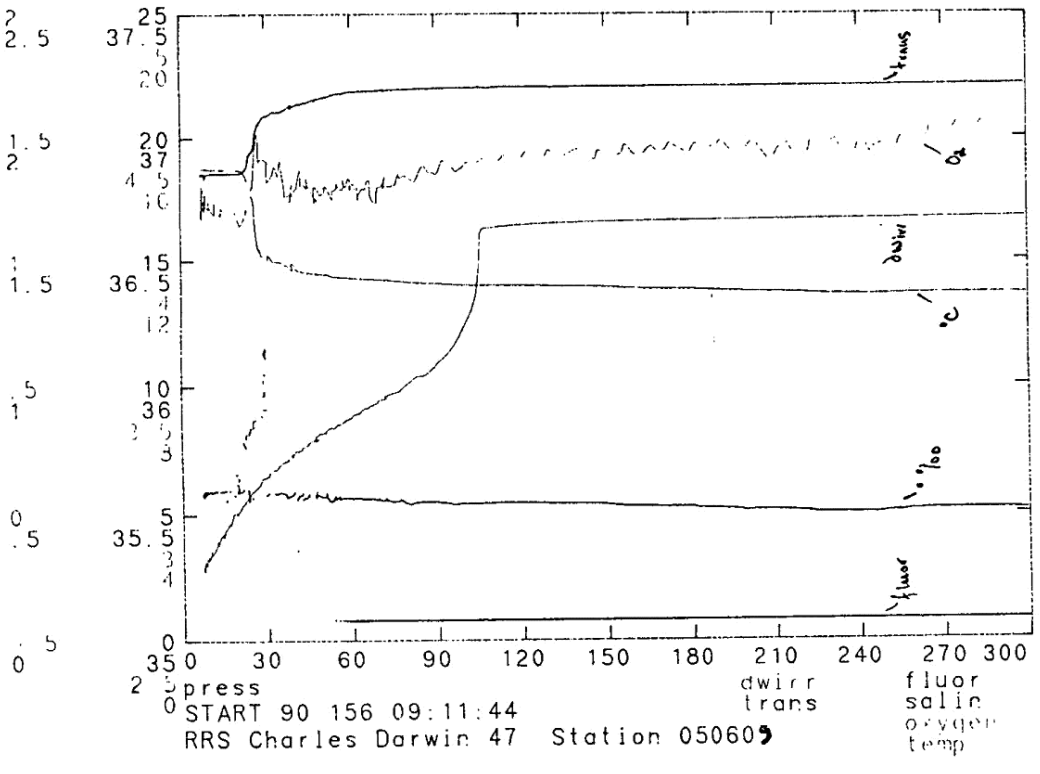
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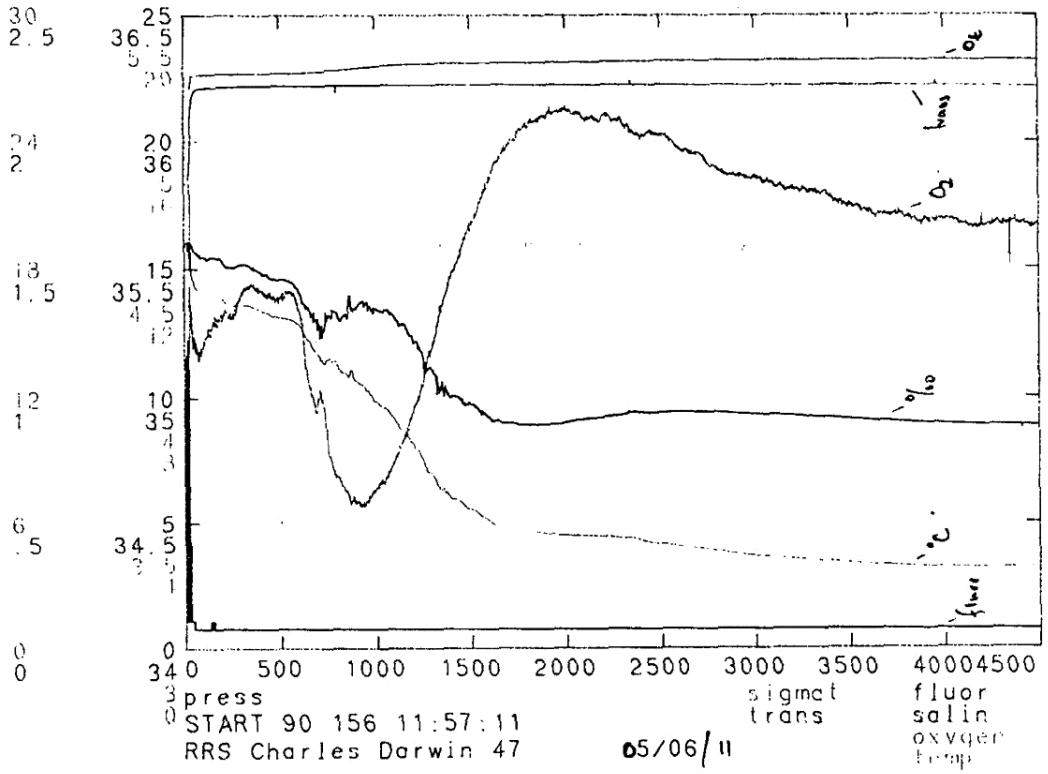
oxygen
temp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05/06/11
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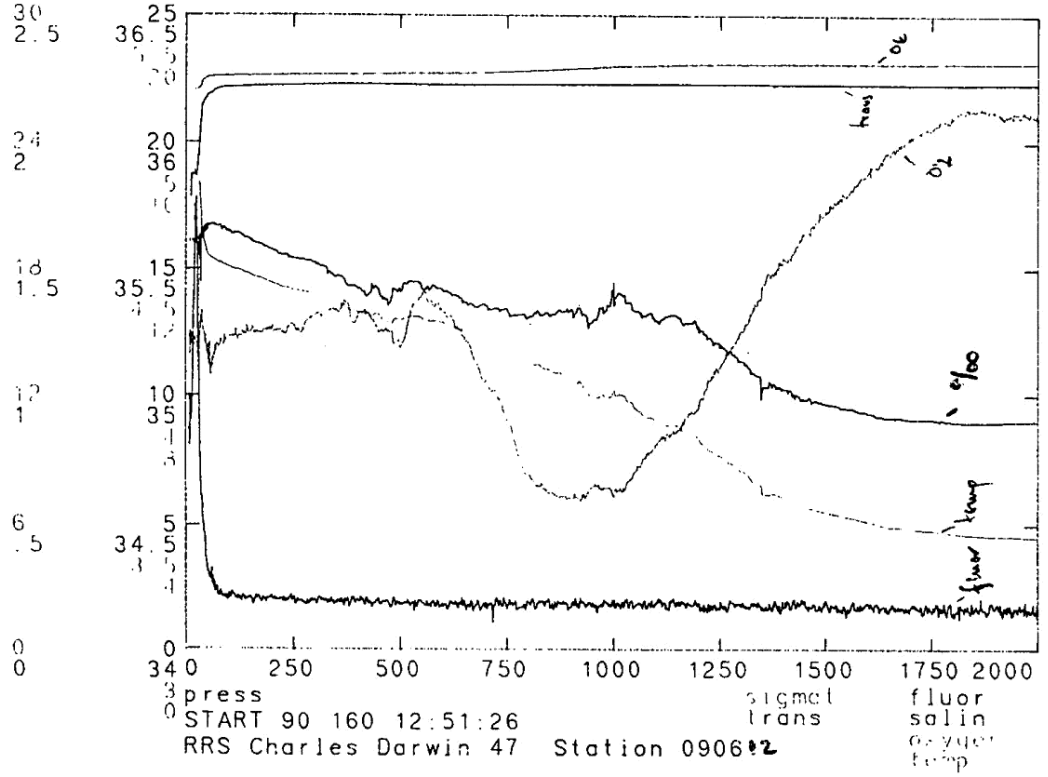
salin
oxygen
temp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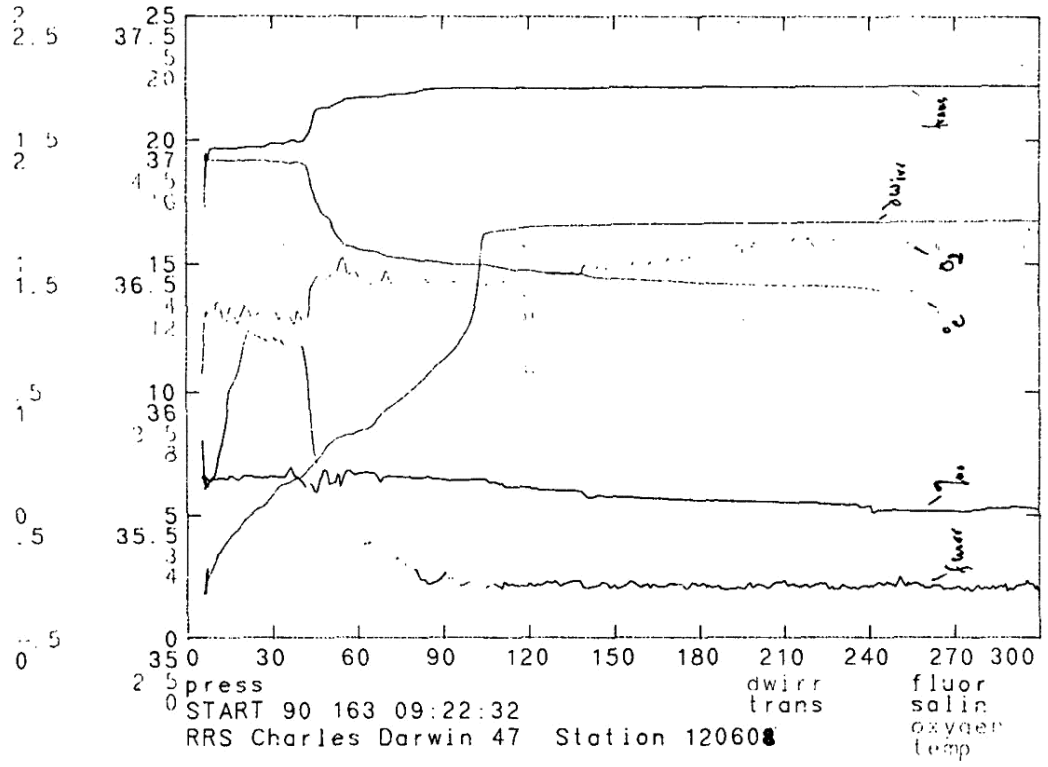
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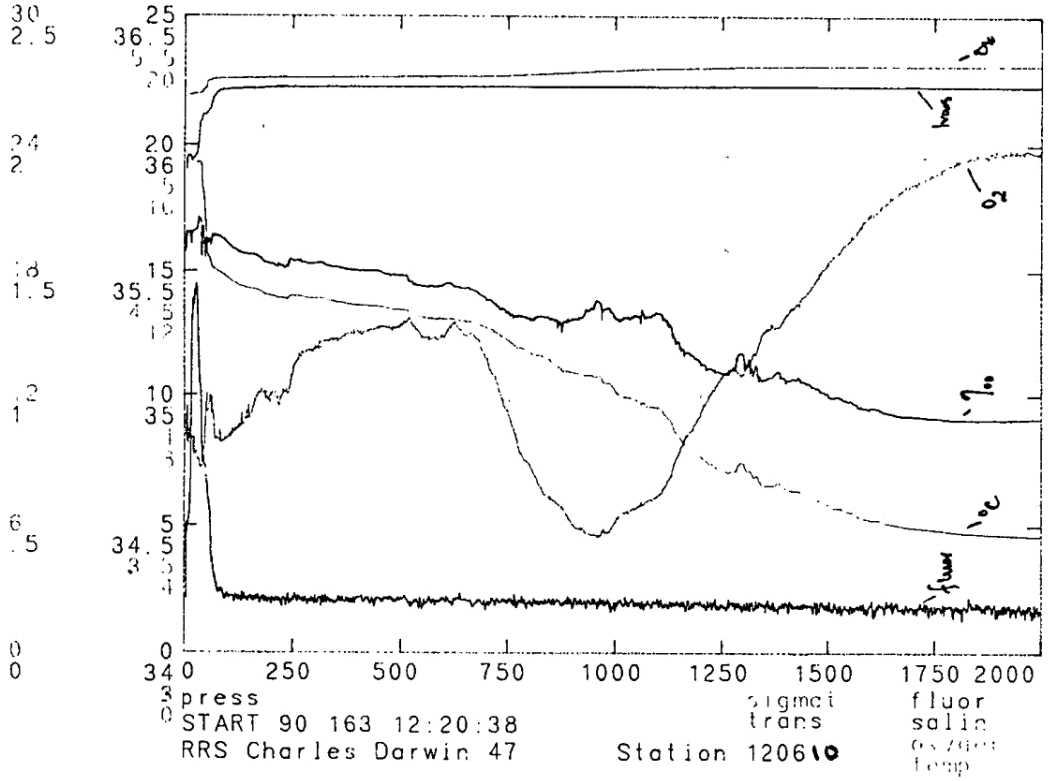
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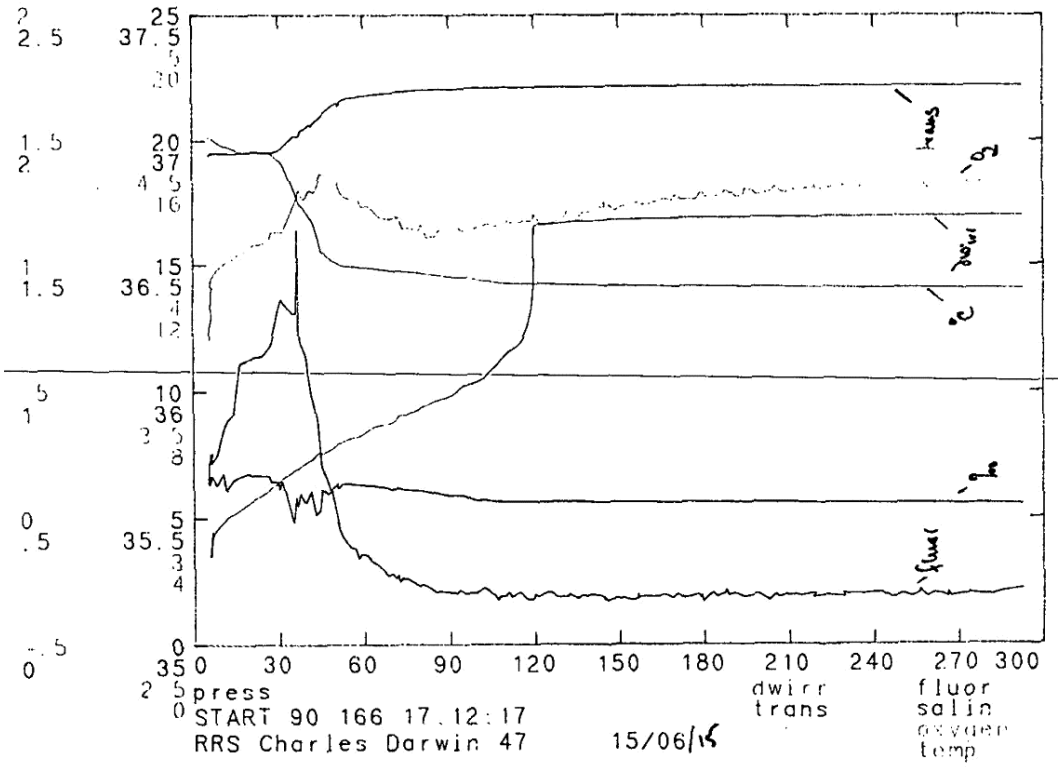
fluor
salin
oxygen
temp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15/06/16
dwirr
trans
fluor
salin
oxygen
temp

CCHDO Data Processing Notes

Date	Person	Data Type	Action	Summary
2007-03-13	Carina,	BTL	submitted	CSV file

10/28/05 Initialized README file
Data from CARINA via Kozyr 5/11/04
Charles Darwin cruise EXPOCODE 74AB047
5/1 - 5/15/1990
71 stations with ??? place Rosette
Chief Scientist - ???

2013-11-22	Barna, Andrew	CrsRpt	Submitted	from BDOC website, PDF

The following files are now available online under 'Files as received', unprocessed by the CCHDO.
cd47.pdf

2013-11-22	Staff, CCHDO	PDF Documentation	Website Update	Available under 'Files as received'
2013-11-23	Lee, Rox	maps	Website Update	Maps created

==========
74AB19900525 processing - Maps
==========
2013-11-23
R Lee

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Process
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Changes

- Maps created from 74AB19900528_hy1.csv

.. _merge:

Merge

Directories
==========
:working directory:
/data/co2clivar/atlantic/74AB19900525/original/2013.11.23_maps_RJL
:cruise directory:
/data/co2clivar/atlantic/74AB19900525

Updated Files Manifest
==========
- 74AB19900525_trk.jpg
- 74AB19900525_trk.gif

2014-01-14	Kappa, Jerry	CrsRpt	Website Update	Final PDF version online

I've placed a new PDF version of the cruise report:

74AB19900525do.pdf

into the directory: http://cchdo.ucsd.edu/data/co2clivar/atlantic/74AB19900525/ .

It includes all the reports provided by the cruise PIs, summary pages and CCHDO data processing notes, as well as a linked Table of Contents and links to figures, tables and appendices.